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HIGH SCHOOL BUILDINGS
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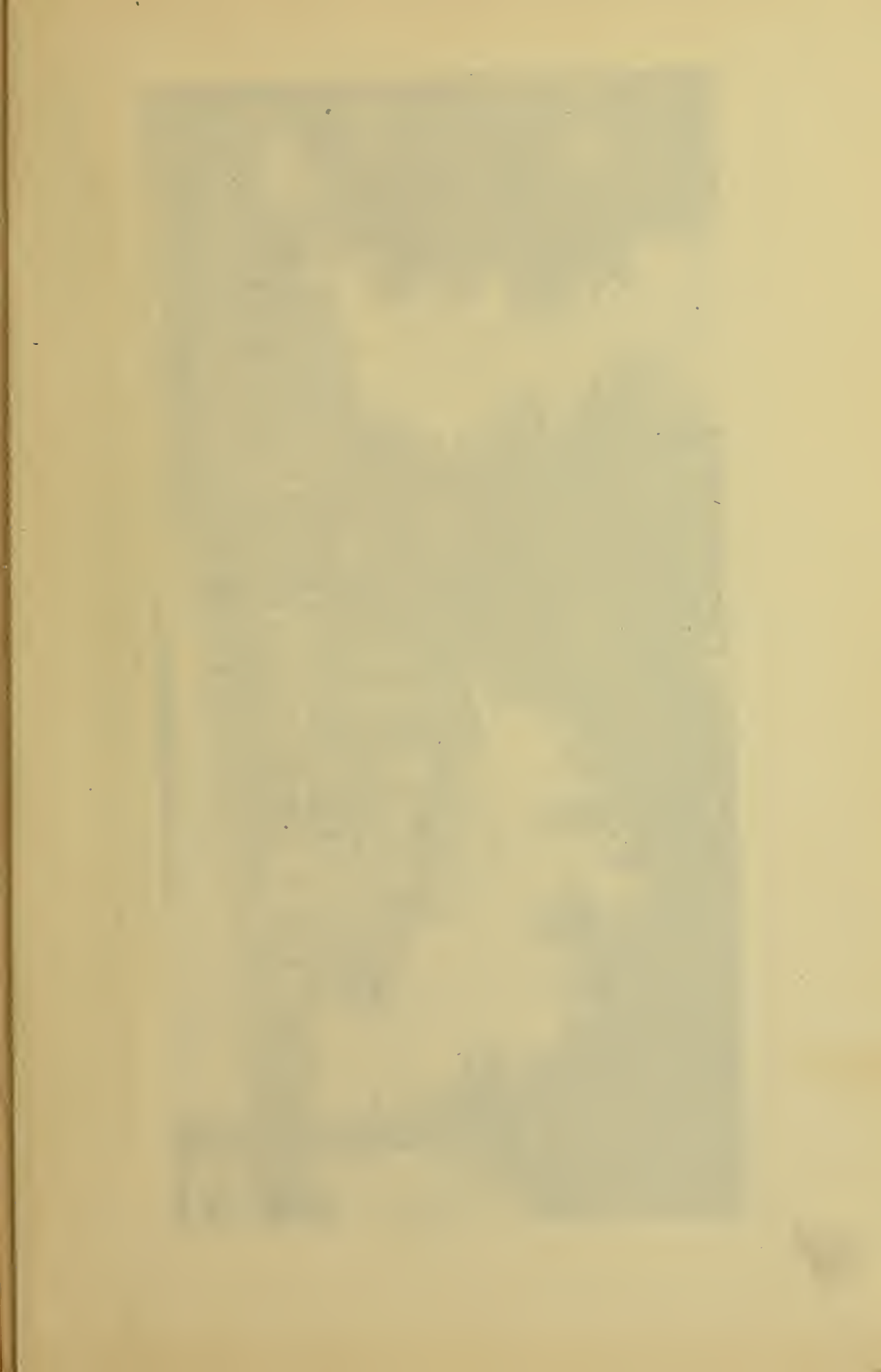
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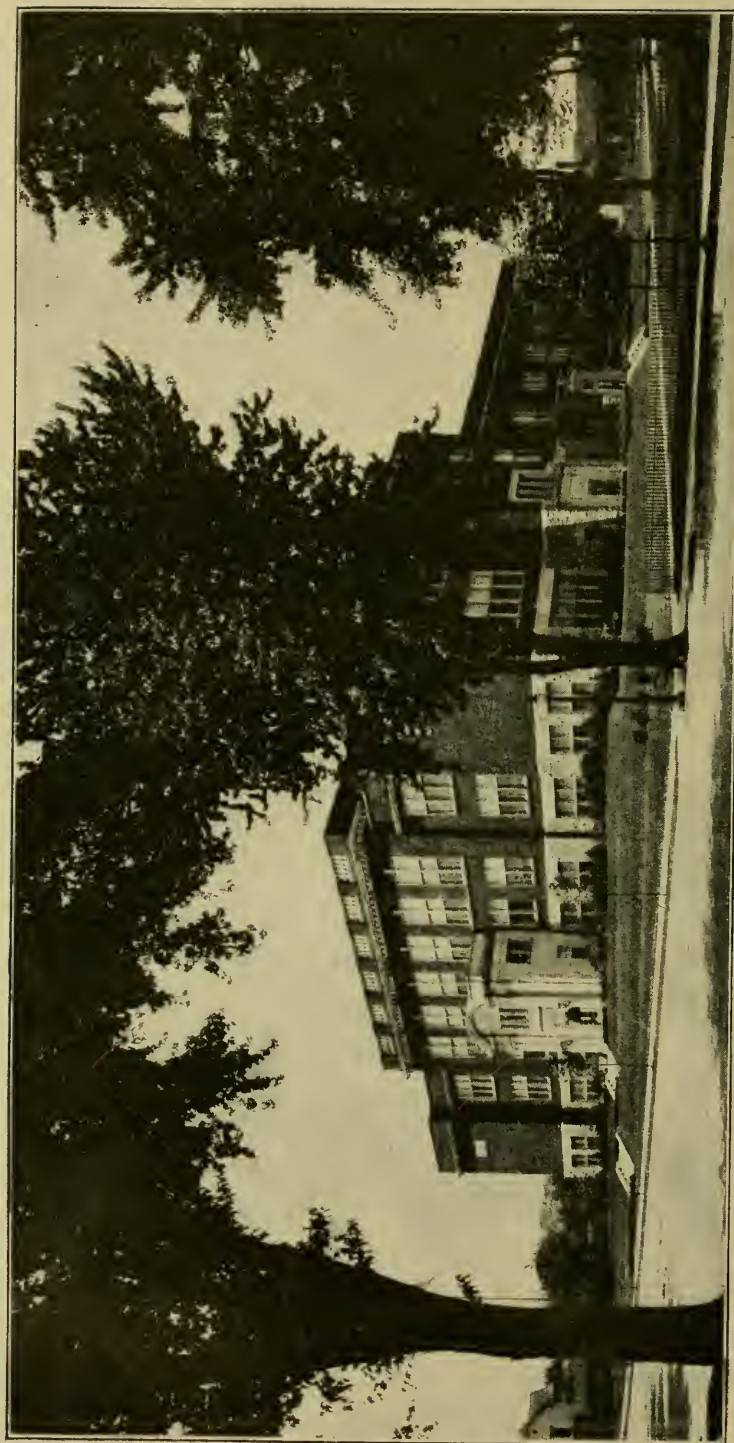
HIGH-SCHOOL BUILDINGS AND GROUNDS

A REPORT OF THE COMMISSION ON
THE REORGANIZATION OF SECOND-
ARY EDUCATION, APPOINTED BY THE
NATIONAL EDUCATION ASSOCIATION



WASHINGTON
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1922





THE EDWARD LEE MCCLAIN HIGH SCHOOL, GREENFIELD, OHIO.

A gift to his native town by Edward Lee McClain. "As promising the greatest good for the greatest number for the longest time."

DEPARTMENT OF THE INTERIOR
BUREAU OF EDUCATION

BULLETIN, 1922, No. 23

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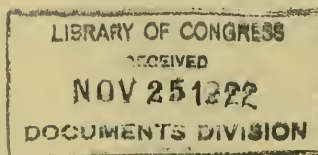
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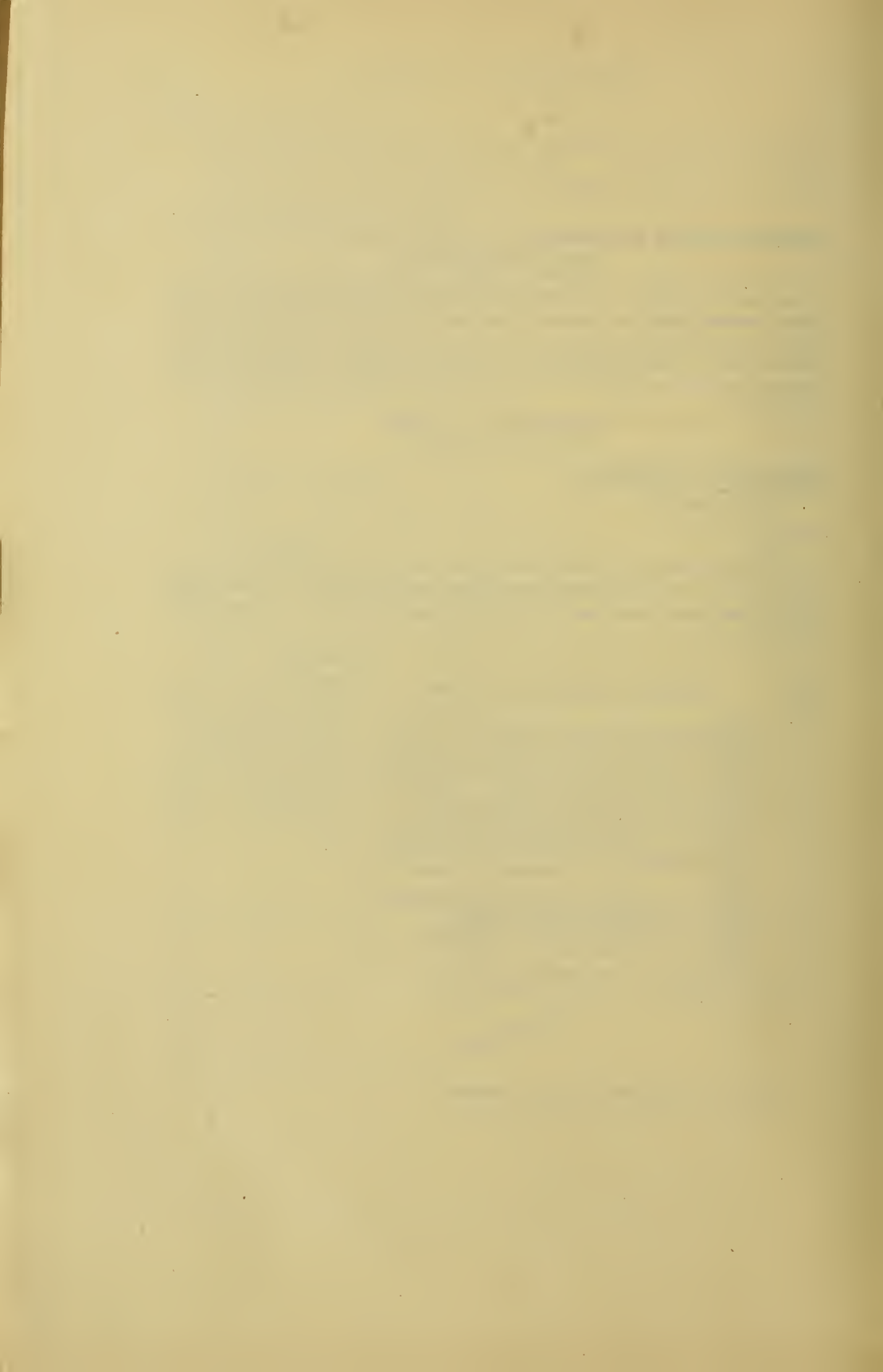
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PREFACE.

The success of any high school depends largely upon the planning of its building. The wise planning of a high-school building requires familiarity with school needs and processes, knowledge of the best approved methods of safety, lighting, sanitation, and ventilation, and ability to solve the educational, structural, and architectural problems presented by the particular building. Moreover, to secure modern facilities without undue expense the architect must be a master of methods of space economy; and to provide for future changes and enlargements he must understand methods of securing elasticity in the plan. To assist school administrators and school architects in their study of a few of the chief problems in this field, the Commission on the Reorganization of Secondary Education is issuing this bulletin.

The bulletin here presented was drafted by William B. Ittner, architect and school specialist, St. Louis, who is a member of the committee on the administration of secondary education, which was originally organized under the chairmanship of the late Charles H. Johnston.

Both the committee on administration of secondary education and the reviewing committee of the Commission on the Reorganization of Secondary Education have at various meetings discussed the report in detail with Mr. Ittner and both committees give their approval to the report.

CLARENCE D. KINGSLEY,
Chairman of the Commission.

HIGH-SCHOOL BUILDINGS AND GROUNDS

Part I.

I. GENERAL STATEMENT.

The development of successful secondary school plants, whether for senior, junior, or four-year comprehensive high schools, must be governed first and foremost by adaptation to local needs and educational policies. In other words, school plants like school curriculums are indigenous and can not be successfully transplanted. A successful school plant in one community may prove an educational misfit and a monument to waste in another. To be sure, there are certain universal principles applicable to all school buildings, such as safety, adequate natural light, ventilation, practical economy, and impeccable architecture. At the same time the requirements for health and recreation, for citizenship, and for vocation are variable and depend far more on the needs of each school community, the ability of that community to meet the needs, and the type of organization of the various educational activities proposed than upon any set of standards.

The most that a report of this kind can do is to enumerate certain conclusions that are the outcome of successful practice. A consideration of them will in no way tend to minimize the necessity for a study of local needs. As long as educational objectives change, and as long as community needs vary, just so long will the outstanding consideration in the art of school planning and construction be the successful adaptation of a school plant to the local educational program.

II. WHAT ADAPTATION INVOLVES.

Since a building must be adapted to serve local educational needs, the initial step should be a survey of educational and housing needs and an analysis of the activities proposed, not only with reference to the immediate present, but also to the future in so far as needs and desires may be foreseen. The community activities to be served by the school must also be considered. Nor is this all. For adaptation requires elasticity of plan so that reasonable changes may be readily and economically made in order to accommodate changes and expansions in the educational program and to care for growth in student enrollments.

III. ELEMENTS COMMON TO ALL SCHOOLS.

Although no set of rules can be formulated for the successful planning of schools for the reasons stated in the foregoing, there are certain requirements which all school communities may justly demand. The requirements include maximum safety, adequate lighting, good ventilation, practical economy, and architectural beauty.

1. SAFETY.

The type of building plan, the number and location of corridors, stairways, and exits, the height of the building, fire-resistive methods of construction, and the elimination of basements constitute the chief elements of safety as far as the building is concerned. Adequate and proper location of the school site is also an important factor.

(A) THE "OPEN" AND "CLOSED" PLAN.

There are two general types of building plans—the "open" and the "closed" plan. The "open plan" has its corridor open to natural light on one side, while in the "closed plan" the corridor is lined with classrooms on both sides, depending on windows at the ends of the corridors, the sash along the inner walls of the rooms, and glass in doors for its light. Owing to the disposition of the classrooms in relation to corridors, stairways, and exits, and on account of the limited areas open to fire or panic hazard, the "open plan" affords maximum safety. The diversity of opinion in regard to the two plans is really due to the difference in cost, the initial cost of the "open plan" being somewhat greater. The saving in cost in this instance, however, is at too great a sacrifice, since it militates against maximum safety and service. Where the open plan is not attainable, a semiopen plan may serve as a compromise. This plan is possible by a partial opening of the corridor to outside light or by placing the stairways along the sides instead of at the ends.



PLATE 1.—CORRIDOR, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MO.

The "open plan" permits maximum light and ventilation in all corridors.

(B) CORRIDORS.

The primary purpose of corridors is circulation and egress. Adequate circulation is necessary to safety. For this reason, if for no other, the proper width and natural lighting of corridors are important and should never be sacrificed

In the interests of additional classroom space. While no fixed rule can be dictated, the minimum width for main corridors of high schools is 12 to 14 feet. Ten feet is sufficient for secondary corridors.



PLATE 2.—MAIN CORRIDOR, EDWARD LEE McCLAIN HIGH SCHOOL.
GREENFIELD, OHIO.

If main corridors are spacious and well lighted, they serve admirably as galleries for both permanent and temporary exhibits.

(C) STAIRWAYS AND EXITS.

One of the serious weaknesses in school buildings is the restriction in the number of stairways for the sake of reducing cost. Stairways, ample in number and so located as to reduce horizontal travel distance from classrooms to stairways and exits, are necessary to safety. And they should serve definite groups of rooms. Then in an emergency, a natural division of students into smaller groups may be formed and congestion avoided. The required number of stairways and exits may be determined by calculating the number of students on each floor and the number of floors to be served. It is a problem for each building. All that can be given is a working rule suggested by practice and experience: Namely, that 120 persons in lines, two abreast, can pass a given point in less than 1 minute. And if the building can be emptied in 3 minutes or less without confusion or congestion, it may be considered safe as far as its circulation and exits are concerned.

In order to avoid overcrowding, every stairway should be in two runs from story to story, should have broad landings and a handrail on the balustrade as well as on the wall. No stair run should be more than 5 feet in width between wall and balustrade. A width of 4 feet 6 inches is preferred. Such a stair run will enable children to descend two abreast in perfect order without pushing or crowding. To expedite the movement of classes, double flights should be installed wherever possible.



PLATE 3.—CORRIDOR SHOWING DOUBLE STAIRWAY, CENTRAL HIGH SCHOOL, MINNEAPOLIS, MINN.

To expedite the movement of classes, double flights should be installed wherever possible.

(D) FIRE ESCAPES.

Fire escapes should not be found upon school buildings designed for the highest degree of safety, unless they are planned as inclosed stairways and the pupils are required to use them for regular passage at least once a day. Experience has proved that the ordinary fire escape will be forgotten in the panic and confusion attending a fire, and that the pupils, unless thoroughly acquainted with them as a means of exit through frequent use, will, by habit, resort to the stairways. The stairways and exits that the pupils are in the habit of using a number of times each day during the entire school year always prove to be the most efficient means of egress in any emergency. If the stairways are properly proportioned to the number of occupants and located with respect to the rapid and orderly dismissal of the pupils, the introduction of so-called fire escapes is likely to prove a menace rather than a further means of safety.

(E) HEIGHT.

In the interest of maximum safety, as well as comfort, the building should be low, preferably not more than two stories, and without basement. A three-story building without basement is better than one having a basement and two stories. Basements are generally the fire breeders in schools; they offer no advantages as instruction quarters on account of insufficient height, inadequate natural lighting, and sluggish natural ventilation even though the window area may be adequate. Nor are they suitable places for the toilets. The best practice eliminates basements entirely, even for the heating and ventilating apparatus, for the latter should be located without the main walls of the building to secure maximum safety.

(F) FIRE-RESISTIVE CONSTRUCTION.

The growing scarcity and increasing cost of suitable lumber, together with constant improvements and reduced costs of fire-resistive construction, is resulting in a greater number of the more substantial type of buildings. Although the initial cost of fire-resistive buildings is greater than the less substantial type, they cost less for maintenance and repairs, and their freedom from fire hazard gives added comfort due to the sense of security.

Where funds will not permit of fire-resistive construction throughout, it will require but a small additional outlay to fireproof corridor floors and stairways. Fifty per cent of the high-school enrollment of the country is in cities of less than 8,000 population. These small cities are generally unable to erect their buildings with fire-resistant material throughout. Compromises are usually necessary. The encouraging element in the matter, however, is that while fire-resistive construction is recommended, safety of buildings depends quite as much upon the type of building plan, upon circulation and egress, height, and the careful location of its site.

2. NATURAL LIGHTING.

Much has been written on the subject of the proper lighting of schoolrooms, and authorities are generally agreed that the light should come from the left side. There is, however, a difference of opinion in regard to the quantity to be admitted, for obviously there is harm in too much as well as too little light. It is also obvious that a window surface necessary for a school in the northern and eastern latitudes will be entirely too great for schools in Florida, southern California, or Texas. State legislation has generally been in the direction of fixing one-fifth of the floor area for glass area regardless of other considerations, and in some cases as much as one-fourth the floor area is demanded. While such regulations may be helpful in preventing serious mistakes by those unacquainted with school planning, they often become too drastic and harmful when applied generally to high-school practice. Indeed, the strict enforcement of such laws in some instances demands the adoption of excessive story heights or expensive methods of construction, which result in burdensome costs of school buildings without commensurate returns.

Cross lighting is, of course, to be avoided, but in the warmer climates it is almost as necessary to provide for a natural air circulation in the room as it is to provide satisfactory lighting. For this reason small windows may be introduced on a second side of the room as well as over the blackboard on its inner wall.

Again, in many buildings, particularly of the one-story type, top lighting is often introduced; while this method of lighting may be ideal for shops and many other rooms where the pupil has the opportunity of shifting his position and adjusting himself to varying conditions of light, it is decidedly questionable whether this method of lighting, alone or in combination with side lighting, will be found generally satisfactory for classrooms. The question of the proper lighting is intimately associated with a number of conditions. Thoroughly satisfactory results can only be attained after a full consideration of all the elements involved.

The proper window surface of a unilaterally lighted classroom depends upon its width as well as its height, and while the ratio of glass area to floor area may be applied generally to traditional elementary schools, its application should be used with discriminating care when applied to high schools. For the reasons given above, it is impossible, therefore, to dictate any fixed standards which will apply equally well to all the rooms in a high school or to high schools in

different localities; it is a problem for the individual building. In a general way, however, it may be stated that with the window surface properly placed with respect to the desk area of the room, the window surface may be limited to one-sixth of the floor area in the South and Southwest, one-fourth in the northern latitudes, while one-fifth may be taken as a good working average for buildings located in the central, eastern, and western States. In the planning of all buildings, however, it is advisable to avoid direct southern exposure for classrooms.

The type of windows to be adopted for a given building is a matter of importance. They may be of the ordinary double-hung type, the revolving or austral type, or the awning or semiopen-air type. In any event, the windows should be arranged in groups, with narrow mullions, and should be carried to the ceiling of the room.

3. ECONOMIES.

Owing to the increasing diversity of curriculums and the continued development of community and continuation school demands, high-school buildings are becoming very expensive structures. Moreover, the growth in secondary school enrollments is forcing a premium on space. Unfortunately, as many as 50 per cent of our school buildings fall short in the efficient use of floor space. The measurement of representative school buildings erected within the past five years in various parts of the country indicates that the floor space devoted to instruction varies from 38 to 65 per cent. Some buildings have twice as high a proportion of space devoted to instruction as others. All of this leads to the conclusion that there is urgent need for more competent advice based on a better understanding of all the factors involved, if school building resources are to be wisely conserved.

To achieve real economy, planning must be based upon an understanding of use. If maximum use of all parts of the plant is secured, then, as a rule, true economy has been achieved. But maximum use can only be realized when the component parts of the school plant are planned with due regard to their particular functions, the equipment they are to contain, and the correlation and multiple uses they permit.

Change in the school's activities and in the operating plan will frequently call for alterations and expansions of the school plant. A carefully developed plan embodies the possibilities of change with a minimum of cost and without impairing the natural lighting and ventilation of any quarters. A building plan to be truly efficient and therefore truly economical must evidence elasticity in the highest degree.

A sane reduction of noninstructional space is a factor in economy. Corridors, stairways, offices, and rest rooms are necessary for purposes of circulation, safety, and administration. But there is a limit to the required size of these quarters, depending largely on the size of the school and the type of organization. None of the necessary space can be successfully sacrificed in the interest of economy, but a well-developed plan reduces noninstructional space to a minimum.

Everything considered, the two-story is more economical than the one-story building because it presents fewer problems. One-story schools for small high schools are justified in climates where light construction is sufficient. But in the colder climates there is no economy in the plan. The numerous exits, the large exposed areas, the long run of water pipes and heat ducts, together with the excessive corridor space makes the one-story building more costly and more difficult to administer, and this without any outstanding educational advantages.

The cost of construction also affects economy. The initial cost of fire-resistive construction is greater than the nonfire-resistive, but it is more substantial and costs less for maintenance and repairs. Those who have the bills to pay are often deluded into believing that cheap construction is economy. But any one familiar with building operations of any kind knows that cheapness with regard to necessary and substantial building projects is the height of waste and extravagance.

Finally, the cost of buildings sometimes becomes inflated on account of over-elaboration. The beauty of the Washington Monument lies in its majestic simplicity. It is not ornamentation that gives architectural distinction to high-school buildings. It is instead, "nobility of mass, directness of design, and fine proportion of component parts." A pleasing exterior is but the evolution of an efficiently planned interior.

IV. ARCHITECTURE.

Although there has been some improvement in schoolhouse design during recent years, school architecture has not progressed generally to any marked extent, at any rate not to the point where it may be said to approximate individuality. American architecture has made notable strides in other public, commercial, and domestic buildings, and while we have not, and probably never shall be able to develop a strictly American style, the work of our ablest architects bears unmistakable evidence of a correct application of precedent to American needs and ideals.

On account of the regularity of the large window spaces and the lack of counterbalancing wall space, school buildings are exceedingly difficult to handle architecturally in a thoroughly satisfactory manner. Nevertheless, it is entirely possible to divorce school buildings from that schoolhouse appearance which has been so characteristic of the buildings of the past, and to give them an architectural individuality which will make them stand out preeminently as the best, most thoroughly planned, designed, and executed structures in the community. The building itself, both in its interior and exterior treatment, should constitute a direct appeal to the best and noblest instincts of the pupil by making his environment indicative of the most refined taste in architectural design and decoration. Such a result, however, can not be brought about through over-elaboration, an involved or complicated plan, or the lavish use of ornament. The best things architecturally are those which evidence restraint and a careful consideration of all the elements involved.

1. THE SELECTION OF AN ARCHITECT.

Recent investigations by the National Education Association's Committee on Schoolhouse Planning and Construction show that schoolhouse planning has been in incompetent hands to an alarming extent. Owing to the many mistakes evidenced in poorly planned school buildings, and the handicaps such mistakes are placing on educational progress, schoolmen are becoming alive to the fact that there is an intimate relation between the building plan and the operating plan of a modern school. Consequently, they are awakening to the importance of employing an expert in school planning. High-school buildings are among the most complicated and difficult structures to plan and construct. They demand the highest type of architectural and engineering ability. Their success or failure depends, in a large measure, on the professional fitness and executive ability of the architect.

There are two methods of selecting an architect:

- (a) Direct selection.
- (b) Selection by competition.

There is abundant evidence through many successfully executed high-school buildings throughout the country to prove that the most satisfactory procedure is to select an architect who, by his professional attainments and executed work, has proven his fitness to handle school buildings.

Where boards of education do not desire to proceed on the basis of direct selection in the appointment of an architect and a competition is held to determine a choice, such competition should be conducted under the program formulated by the American Institute of Architects.¹ The institute recently compiled and issued its Circular of Advice which includes a statement of the principles that should govern competitions. This circular is intended as a guide to all who are interested. Committees of the various chapters of the institute throughout the country are authorized to give their approval to competitions when so conducted.

V. THE COMPONENT PARTS OF THE SECONDARY SCHOOL PLANT.

1. THE SITE.

Proper location and adequate size of a high-school site are requisites to the success of the building project. An improperly located site may prove a menace to health and may render a school more or less inaccessible. A restricted site defeats, at once, the possibilities of expansion, increases the difficulties of a commanding setting, and limits the outdoor educational opportunities. The demands upon the size of the present-day high-school site are as follows: Adequate space for physical education, athletic and recreational quarters; provision for gardening and horticulture in connection with agriculture and botanical courses; sufficient space for lawns and landscape gardening; and space for the expansion of the building without encroaching upon the foregoing.

(A) LOCATION.

Location includes topography and environment. It is important to guard against filled or made ground, excess moisture, and improper drainage. Desirable sites are high and well drained. Low ground entails needless expense for under drainage to insure a dry and healthy condition in the building. Filled ground is usually undesirable and insanitary, due to contamination of the soil. Difficulties in the construction of foundations also add materially to the cost of buildings erected on filled ground. Differences in grade, which might appear disadvantageous, often furnish the opportunity for a commanding setting of the building, as well as the means of keeping it immune from ground moisture.

It is desirable that the high-school plant be located reasonably accessible to its present and potential high-school population, but this matter should not outweigh environment and size of site. Students in the secondary schools can well afford a longer walk if, upon their arrival at school, they can work amid pleasing surroundings, with an abundance of fresh air and light, and freedom from the noise, dust, and danger of the street.

¹ Standard form of competition program, authorized by the American Institute of Architects. The Octagon House, Washington, D. C.

(B) AREA.

There is abundant evidence from experience to prove that no high-school site should be less than 3 acres for the most modest building. Of this space 2 acres are necessary for physical education. (See Development C.) Five acres is the minimum for a school of 500 pupils. Nothing short of a 10-acre site will suffice for large schools. And even the school of 500 pupils requires this larger site if it is to include a general athletic field with accommodations for spectators. A 12 to 15 acre site is always desirable.

Adequate sites for schools in the smaller cities and towns are quite readily secured. For obvious reasons, school authorities in the larger cities have far more difficulty in securing large areas. In some instances, the problem has been solved in a fairly satisfactory manner by restricting the site of each building to the area necessary for light, air, the outdoor physical education games and class exercises that can be conducted in a moderate-sized space, and the proper setting and estimated expansion of the building, and by appropriating a single large area, central to a group of schools, to be used as an athletic field in common. Wherever sufficient foresight has been exercised and large areas acquired well in advance of city improvement, the problem is easily and economically solved. To-day most of our young, rapidly growing, industrial cities are pursuing this policy and realizing its benefits. When adequate sites for high schools in congested cities are difficult to secure, boards of education should not fail to use their power of condemnation in order to acquire what is consistent with the larger educational demands and developments.

(C) DEVELOPMENT.

The development of the site involves the correct location, orientation, and setting of the building, allotment of space for its expansion, space for planted foreground, gardens, and outdoor quarters for physical education and recreation. Even though all the improvements can not be undertaken at once, a comprehensive plan must be made at the outset and adhered to in developing the site.

Many of the new high schools are evidencing careful thought with regard to their school lawns and planted foreground. Some communities are even employing landscape architects to develop the park and garden areas and are organizing their building and maintenance corps in such manner that the care of the grounds is assured. And why not? Aside from their æsthetic value there is no reason why park spaces should not be considered as important educationally as greenhouses and indoor laboratories.

The amount of space set aside for gardens will depend largely on the size of the school and the practical emphasis on the botanical and agricultural courses and the method of organization of the gardening activities. The close proximity of greenhouses to the gardens, whenever the former are included, adds materially to the ease of administration of both quarters.

Experience has shown that the outdoor quarters for physical education are most successful when located toward the rear of the building and in close correlation with the indoor quarters. There are other successful locations, but in general the simplest and most satisfactory is usually the rear location.

To meet standard requirements as to space, the smallest school should have at least two acres for outdoor physical education. This space should include space for baseball, which space will also serve football. Space for two volley ball games and one playground ball game is recommended. About 100 students in action can thus be accommodated at one time. If the school is to contain more

than 600 pupils, the outdoor physical training space should accommodate over 100 pupils at a time and hence must be enlarged proportionately. A quarter mile running track, pole vaulting, running broad jump, running high jump, standing broad jump, and a spectators' stand wherever included will demand additional space.

A large school can always offer greater and more varied outdoor opportunities to its students than the small school for the same reason that the large cities can offer a greater variety of work and recreation because they represent a concentration of forces. Cities that pursue a policy of a large number of small schools with restricted sites can not hope to develop the adequate physical education layouts that cities with fewer but larger units can offer. The principle of centralization applies to all schools but in particular to high schools, because in the latter, distance does not loom as an impossible obstacle.

2. THE BUILDING.

(A) HEALTH PROVISIONS.

The Commission on the Reorganization of Secondary Education recognizes *health* as a fundamental objective. If health is to receive proper consideration in secondary education, then adequate provisions for health must receive the foremost consideration in the planning of the school plant.

The first requisites to a realization of health as an educational objective are safe, well-lighted, and ventilated work and study rooms. Every school environment should be a model for health. Sanitation, good lighting, airiness, and cheerfulness of surroundings are the eternal watchwords of a real school architect. "Cleanliness next to godliness" ought to be the slogan of the housekeeping corps of school buildings. The proper location of the school plant, adequate site, and an efficient building plan ought to result in a physical environment that fairly radiates health and wholesomeness. Nothing but a well-organized janitorial service, however, will maintain it as a model of health.

Health programs in high schools generally include, aside from the outdoor varieties, the physical activities in gymnasiums, the physical examinations, medical inspection, and instruction in personal and community hygiene. The scope of these activities varies all the way from those in the small schools where practically all the work is developed by one physical director in a limited space to those in the large, comprehensive high school where many specialists such as physical examiners, nurses, gymnasium, swimming, and athletic instructors are employed and the physical activities are so diversified that the needs of all groups may be met.

Owing to the variance in kind and scope, the physical education quarters can not be standardized except for schools of similar size and types of organization. The best school practice, however, has established definite minimum requirements for gymnasiums and accessories. But these are by no means fixed. As guides, however, they render a distinct service.

Two gymnasiums, one for girls and one for boys, are always to be desired in high schools. In small high schools, one normal-sized gymnasium serves the principal requirements, but the full development of the physical education and recreational activities of high-school students is always more readily attained with two gymnasiums. In some instances one large gymnasium divided by a movable partition may well take the place of two separate gymnasiums.

Experience has proven that 50 by 80 feet is a normal floor space for gymnasiums, although 60 by 90 feet are better dimensions. No gymnasium should be less than 18 feet under beams and trusses.

In the matter of location the unvarying requirement is that the gymnasium must receive maximum light and ventilation. This is impossible if it is below grade or if basement rooms are used. It is essential that the gymnasium floor be above grade. In some schools it is on the same level as the auditorium stage. Although gymnasiums may be above the out-door playground level, for purposes of convenience they should lead directly to the playground. Aside from this correlation with the out-door quarters, it is frequently desirable to institute a close connection also between the auditorium, the lunch room, and the gymnasium, in order to give complete accommodation to the social activities and the community uses of these quarters.

Windows on three sides are desirable to insure plenty of sunlight and maximum ventilation. Windows at floor level are desirable for natural ventilation.



PLATE 4.—SWIMMING POOL, CENTRAL HIGH SCHOOL, WASHINGTON, D. C.

If swimming pools are to become valuable additions to the physical education quarters, they must be properly lighted and ventilated, and constructed under the strictest rules for sanitation and safety.

To allow for adequate space for wall apparatus, some of the windows should be set at least 7 or 8 feet from the floor.

A running track in a school gymnasium, if properly installed and banked as it should be for speed, requires a story height of at least 24 feet. But the limited use which can be made of it scarcely justifies the extra cost. The place for the running track is out-of-doors.

If swimming pools are to become valuable additions to the physical education quarters, they must first be properly lighted and ventilated, and constructed under the strictest rules for sanitation and safety. The minimum standard size of pools is 21 by 60 feet with adequate head room for diving at the deep end of the pool. Unless all conditions are favorable to the installation, administration, and upkeep of swimming pools, they had better be omitted. Frequently, owing to faulty installation and neglect or lack of understanding in their care, they become a menace. It is scientifically possible, however, to make the swimming pool thoroughly sanitary and hygienic.

A sunlit pool, with the proper systems of water refiltration, circulation, purification, and heating, in connection with a sanitary method of handling showers, bathing trunks, suits, and towels, is stimulating to persons of all ages. It adds materially to the interest of the physical education activities of the school, and constitutes a distinct community asset.

Regardless of the quality of the water supply for the pool, an approved system of water filtration, purification, and heating is necessary. Since a dip in the pool must always be preceded by a shower, the proximity of showers and dressing rooms becomes mandatory.

Separate shower, locker, and dressing rooms for boys and girls are, of course, necessary. The number to be installed and the arrangement depend almost wholly on the number of students to be accommodated in the physical



PLATE 5.—BOYS' GYMNASIUM, CENTRAL HIGH SCHOOL, WASHINGTON, D. C.

Experience has proved that 50 by 80 feet is a minimum floor space for gymnasiums. The minimum height varies from 18 feet to 24 feet under beams and trusses.

education quarters each period, and the method of handling class groups. It is a problem for each school. Usually 10 showers are sufficient for a class of 50 boys. More are required for girls. The most satisfactory results are secured when showers are arranged for both individual and multiple control. For completeness of accessory rooms, an extra dressing room and several additional lockers for visiting teams is a desirable inclusion. Drinking fountains and toilets should also be included, but the number will vary with varying school conditions.

Space for spectators by means of which opportunity may be given for viewing exercises, exhibitions, and games is a desirable adjunct to every gymnasium. There are various ways of securing such space. In the case of two gymnasiums separated by a movable partition, one of the rooms may be arranged with a lifting tier of seats, which may be lowered into place whenever desired. This arrangement will accommodate a large number of spectators. Another plan and a more common one is the gallery arrangement, and still another the use of the second floor corridors with double windows



PLATE 6.—GYMNASIUM, EDWARD LEE MCCLAIN HIGH SCHOOL, GREENFIELD, OHIO.

The unvarying requirements for gymnasiums are maximum light and ventilation.



PLATE 7.—GYMNASIUM, HIGH SCHOOL, SPRINGFIELD, ILL.

There are various methods of securing space for spectators. In the case of two gymnasiums separated by a movable partition, one of the rooms may be arranged with a lifting tier of seats which may be lowered into place whenever desired.

opening into the gymnasium. For games such as basket ball, portable bleachers may be placed along the sides. In schools where the stage gymnasium is provided, the auditorium serves for spectators.

The offices for the gymnasium directors, the conference, medical, and examining rooms may be arranged en suite with the offices opening directly to the gymnasium as well as indirectly to the playground. Maximum air and sunlight are as essential to these quarters as to the gymnasium and pools. The installation of running water and toilets is also important.

(a) CORRECTIVE GYMNASIUM.

In large schools, a small gymnasium (usually about 25 feet by 50 feet) is sometimes provided for students who will be benefited by special corrective exercises, and is strongly recommended. Requirements with respect to light, air, and accessories listed for the regular gymnasium apply with equal force to this room. It will give most efficient service if located near the regular gymnasiums.

(b) OUT-DOOR GYMNASIUMS.

Roof gymnasiums for open-air activities are readily made available by roofing the area over the regular gymnasium. When properly arranged and equipped with drinking fountains and toilets, they become valuable for all types of physical welfare and social activities, especially during the warmer seasons.

(c) DETACHED GYMNASIUM.

In many schools having adequate site and playground, it may be advantageous to place the gymnasiums in a separate building devoted exclusively to the physical education activities. It should be located, of course, in proper relation to the athletic field or out-door recreational quarters. A detached building generally includes the gymnasiums, lockers, dressing and shower rooms, toilets, conference and medical rooms, instructors' offices, storage rooms, and a spectators' gallery of generous size.

(B) CLASSROOMS.

The three variations of classrooms in high schools include the regular classroom, the laboratory, and the study room.

It is futile to attempt a drastic standardization of regular and laboratory classrooms since their size must vary with use, equipment, and size of class. If they are large enough to accommodate a normal class, which should not exceed 30 students, waste will be reduced to a minimum. The classroom should contain ample space for reference material. A few larger rooms may be included to meet special needs. The width of normal classrooms should not be less than 22 feet and not more than 24 feet.

Having determined the proper-sized unit, the plan should be arranged with the heat and vent ducts or openings along the corridor walls, and in such manner as will readily permit two or more units to be thrown together. Partitions between rooms should be nonsupporting. Thus opportunity is given for expansion from a single classroom to one and one-half, two, or more units, without serious changes in construction. The school is thus rendered elastic and capable of adjustment in meeting reasonable changes in the program.

A single door for each classroom is desirable and this should swing outward to the corridor. The part-glass door is recommended. In many schools intercommunicating doors between classrooms are deemed advisable.

The group plan for laboratories is usually successful. The grouping will depend on the correlation of subjects. On account of the special equipment, laboratory classrooms will require a larger floor area than the regular classroom. And leaders in science teaching are recommending a further increase in floor area, so that demonstrations, the student laboratory exercises, discussions, and recitation can all be conducted in the one room. This obviates the necessity for special lecture rooms adjacent to laboratories. If instructors' rooms and storerooms are desired, it is essential that they be arranged en suite and connect directly with the laboratories.

There is no standard location for laboratory classrooms. The type of activities, the method used, and the correlation desired must determine location. The best practice, however, places the agricultural and biological laboratories upon the ground floor. This location assures a direct connection between botany laboratories, the greenhouses, and out-door gardens. It also expedites the



PLATE 8.—CHEMICAL LABORATORY, GROVER CLEVELAND HIGH SCHOOL,
ST. LOUIS, MO.

On account of the special equipment, laboratory classrooms require a larger floor area than regular classrooms.

handling of live stock or motor-driven farm machinery for demonstration purposes in the agricultural laboratory.

In many high schools study rooms are confined to one or two large rooms connecting directly with the library; in small schools the study room and the library are often combined in one room. As the number and size of study rooms will depend upon the size of the school, the program of studies, and the type of organization, only a few definite statements can be made regarding them. Central location, convenience to stairways, and proximity to school library are principles that apply to all types of study rooms.

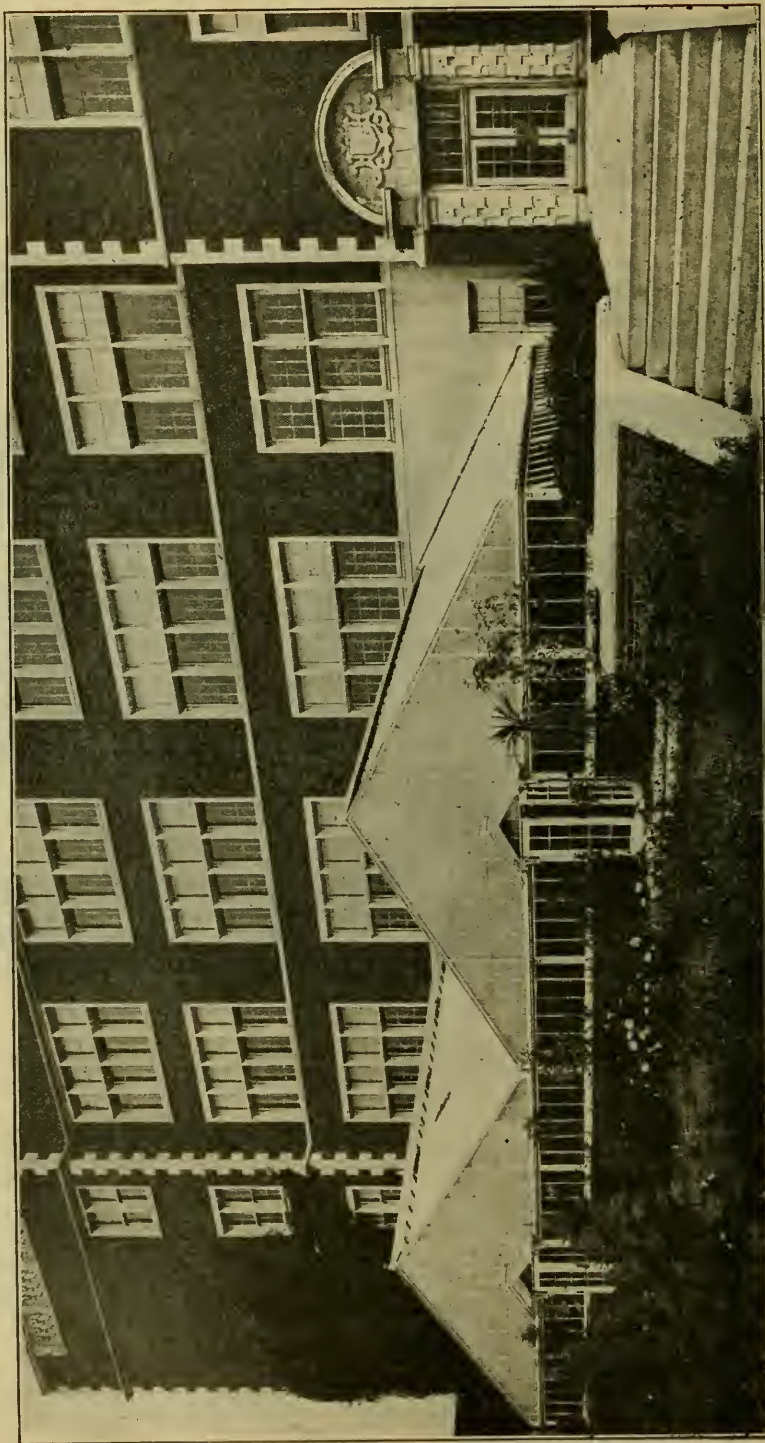


PLATE 9.—BOTANY LABORATORIES (EXTERIOR), CENTRAL HIGH SCHOOL, MINNEAPOLIS, MINN.

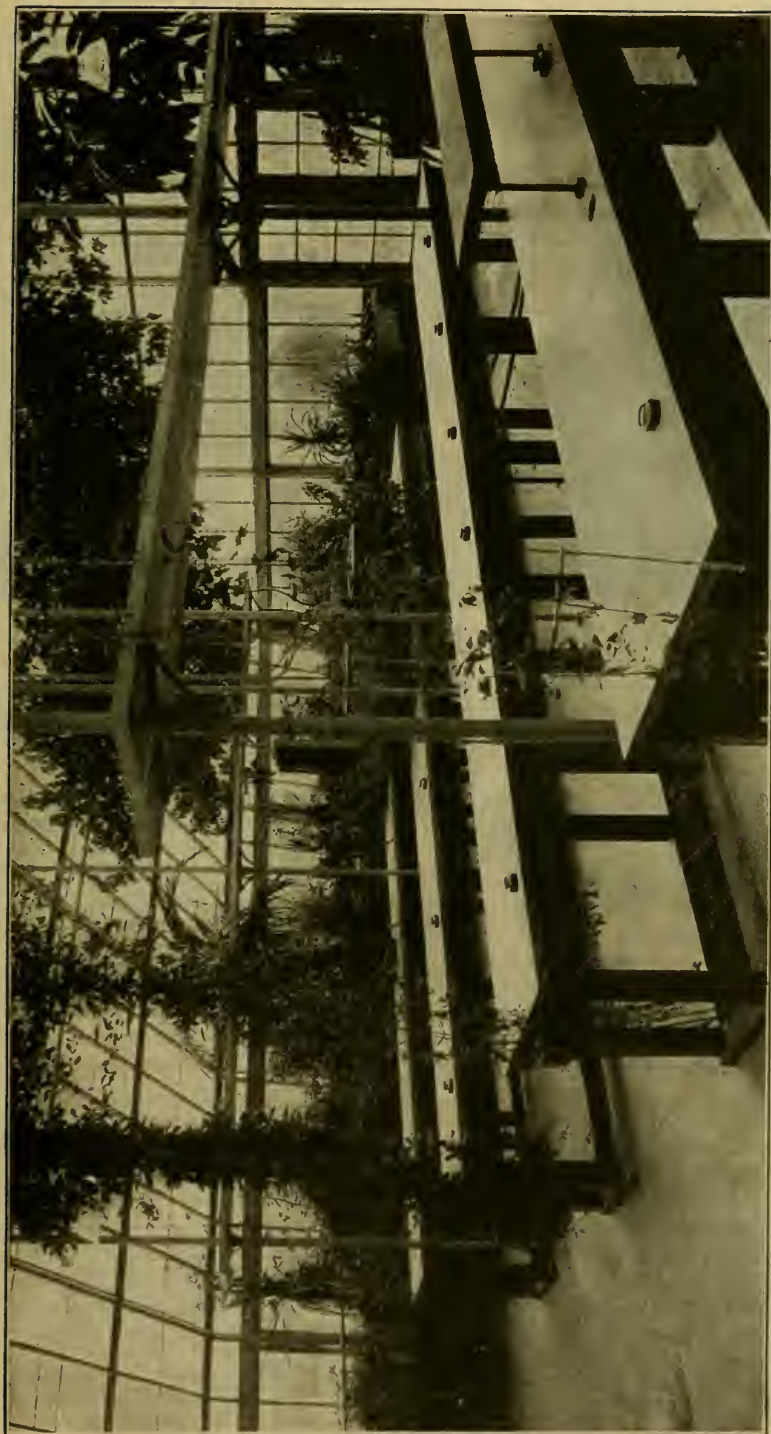


PLATE 10.—BOTANY LABORATORIES (INTERIOR), CENTRAL HIGH SCHOOL, MINNEAPOLIS, MINN.



PLATE 11.—PLANT ROOM, ADJACENT TO BOTANY LABORATORIES, CENTRAL HIGH SCHOOL, WASHINGTON, D. C.

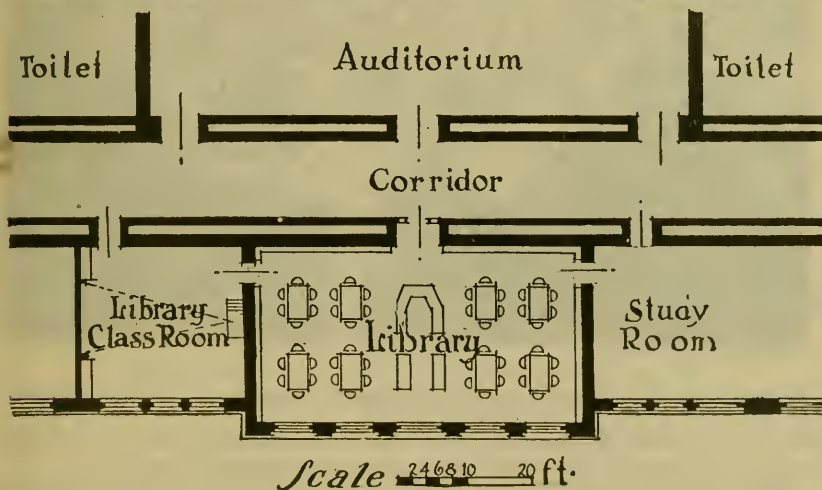
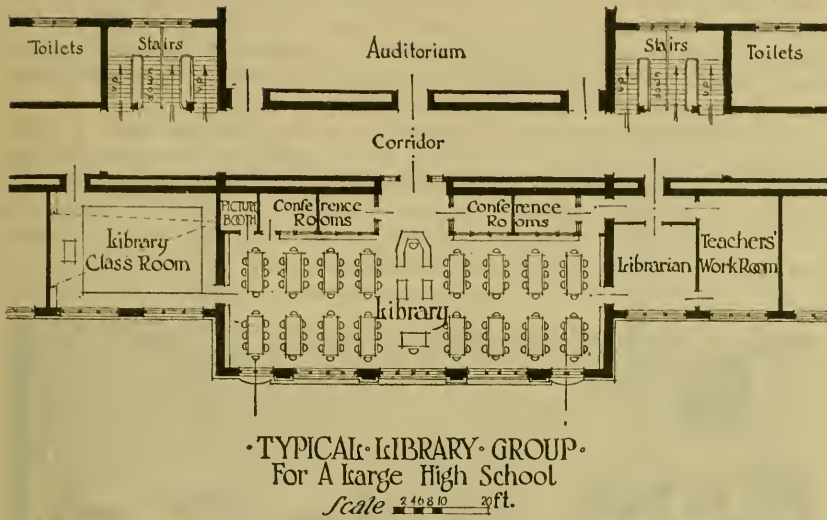
A glassed-in area for plant propagation, connecting directly with the botany group, is sometimes preferable to greenhouses.

(C) THE SCHOOL LIBRARY.

The school library group has become one of the most vital, as well as interesting, features of the modern high school. It offers opportunity to school administrators and the architect to depart from fixed conventions of school procedure. Educationally, it constitutes one of the most effective units; architecturally, it lends itself to characteristic treatment both in furniture and decoration.

For the small high school, the library group is usually restricted to a main reading room, a conference room, and a workroom for the librarian. In the large high schools, the accessory rooms are frequently increased to several conference rooms for the group project work and may even include one or more classrooms for library courses, a store room, a stack room, and room for journalistic enterprises.

Owing to the variation in the use of the school library, the sizes of its component parts can not be safely standardized. If, however, the main reading and reference room accommodates 10 per cent of the student body at a time, and the accessory rooms are planned in relative proportion, the group should be of sufficient size for the most extensive demands now being made of libraries. The accessibility of the library to all parts of the building and its close connection with study rooms are essential considerations. The former necessitates a central location, and the latter either a plan whereby the library opens directly into study halls at each end or connects with them by special passageway.



TYPICAL LIBRARY GROUP FOR A SMALL HIGH SCHOOL.

(D) AUDITORIUMS.

The need for auditoriums in high schools is so obvious that a discussion of their function is unnecessary. As yet, however, only a few schools have realized the possibilities of the auditorium as an educational factor. That it is a socializing and recreational unit has been sufficiently proved and it can become also a vital instructional force. Its eventual development as such must be anticipated by the school architect.

The proper size of school auditoriums has occasioned some discussion. Many of them are overlarge in the interest of occasional large gatherings. While there are some advantages in having auditoriums accommodate the entire student body in schools of over 1,000 pupils, there are also certain disadvan-

tages, and whether the result is commensurate with the cost involved is open to question. The tendency in the development of auditorium work is in the direction of work with smaller groups, and an oversized auditorium for these smaller assemblies is not practical. It becomes an educational obstacle rather than an aid, to say nothing of the waste space it represents.

Medium-sized auditoriums, if planned in correct relation with a stage-gymnasium and separated therefrom by a sound-proof movable partition, can always be enlarged for special occasions. Experience has proved that it is altogether feasible to expand the stage to the size of a standard gymnasium and by this method to increase the seating capacity of the auditorium whenever desired. The combination stage-gymnasium also has other advantages. It gives opportunity to view physical educational exhibitions from the audi-



PLATE 14.—LIBRARY, HIGH SCHOOL, FARGO, N. DAK.

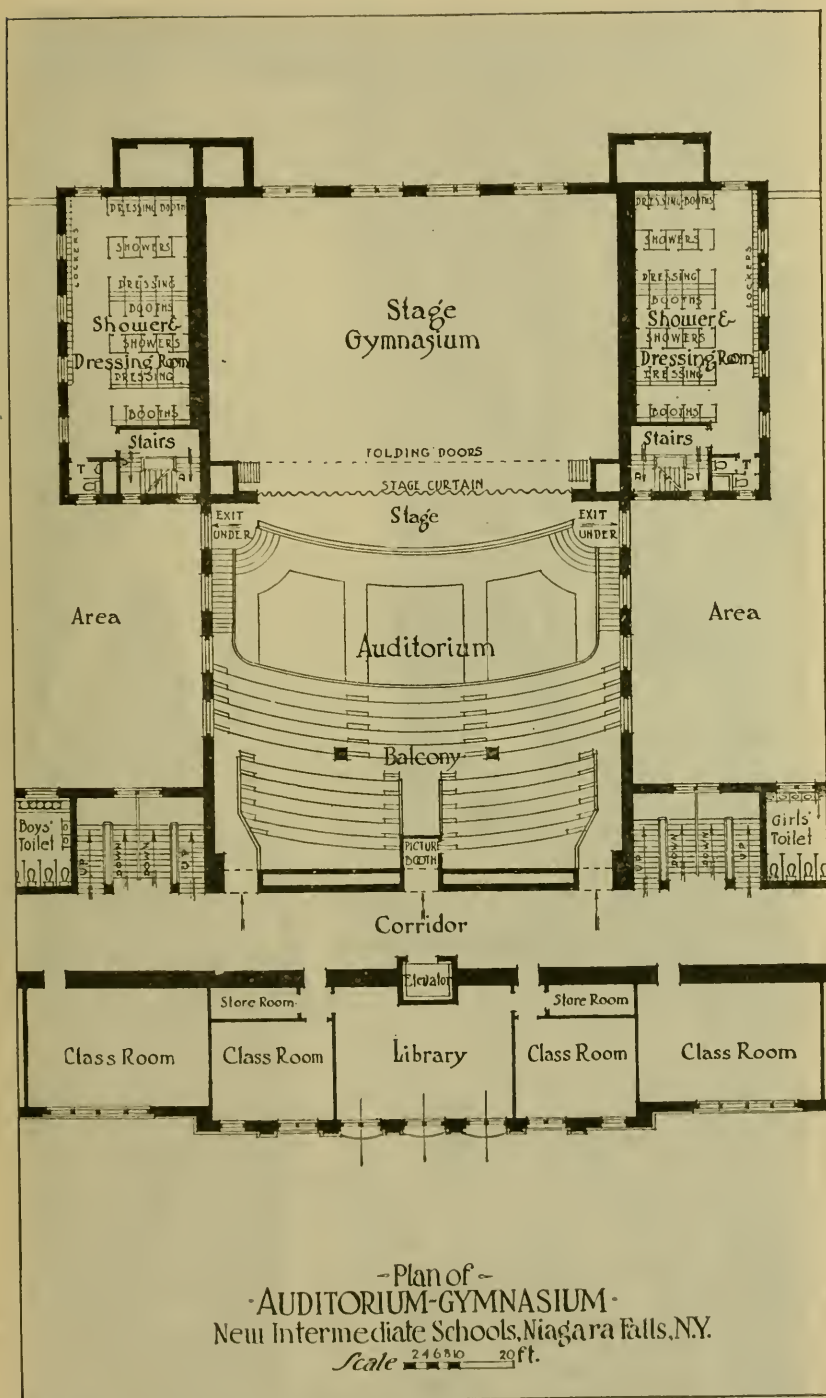
The school library offers opportunity to depart from the traditions of school procedure.

torium and makes provision for large choruses, symphony concerts, and community activities for which an ordinary stage is always inadequate.

The tendency in medium-sized auditoriums accommodating 600 to 800 pupils is to eliminate balconies for the reason that they create a more difficult administrative problem and add nothing to the educational possibility of an auditorium. A sloping floor with seatings rising in amphitheater fashion from the first to the second floor level has proved most satisfactory.

A central location upon the first or main floor is usually the most satisfactory for school auditoriums. This location will secure ease of circulation to the main, as well as to the side or secondary corridors, and to the various floors of the building. It is necessary to safety and efficiency of administration and adds to the encouragement and convenience of community uses. In the "open plan" type it forms the main axis of the building with windows on two opposite sides. Thus unlimited natural lighting and ventilation are readily secured.

In small schools the auditorium and gymnasium may be combined in a single room. Such room must be planned primarily as a gymnasium of standard



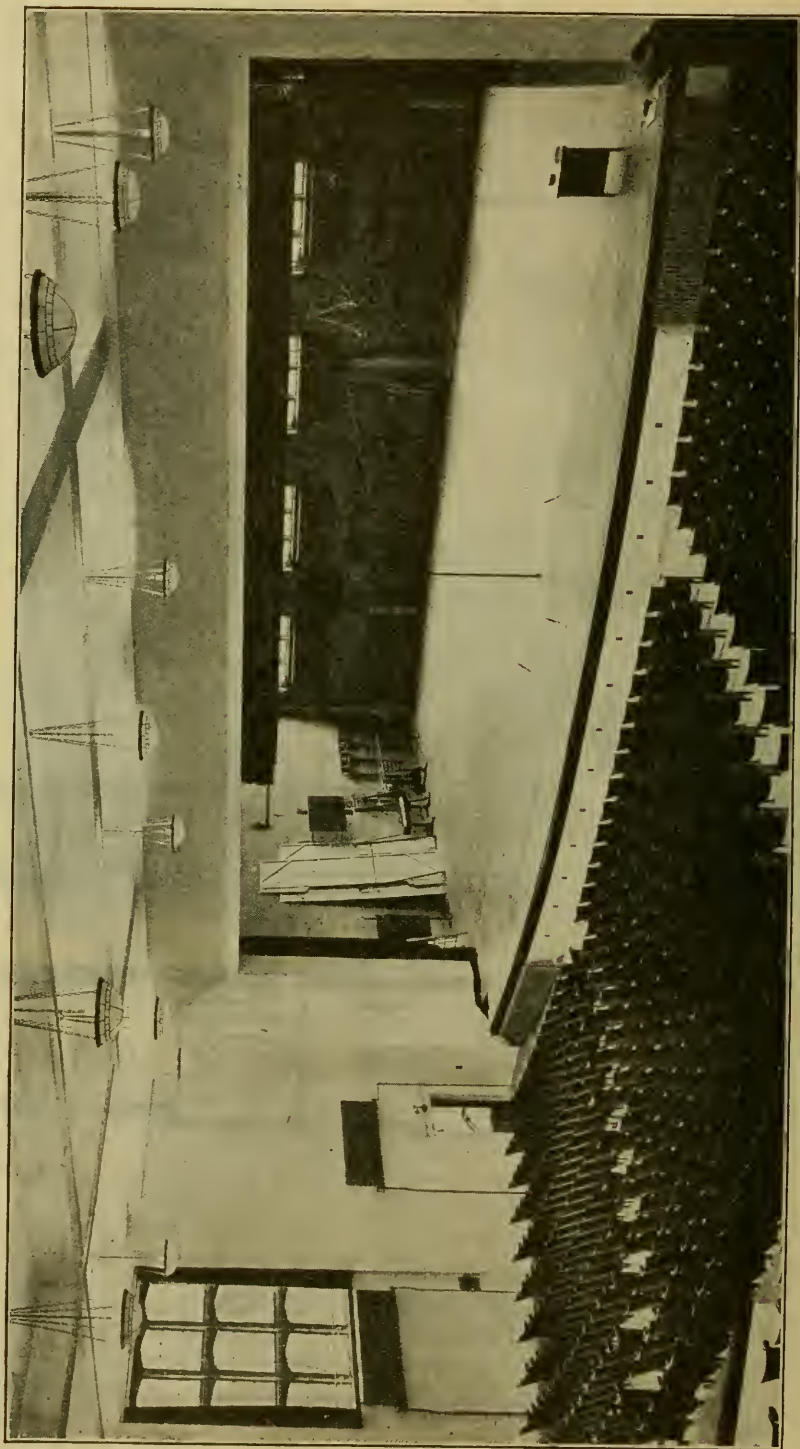


PLATE 16.—AUDITORIUM-STAGE-GYMNASIUM, HIGH SCHOOL, FARGO, N. DAK.

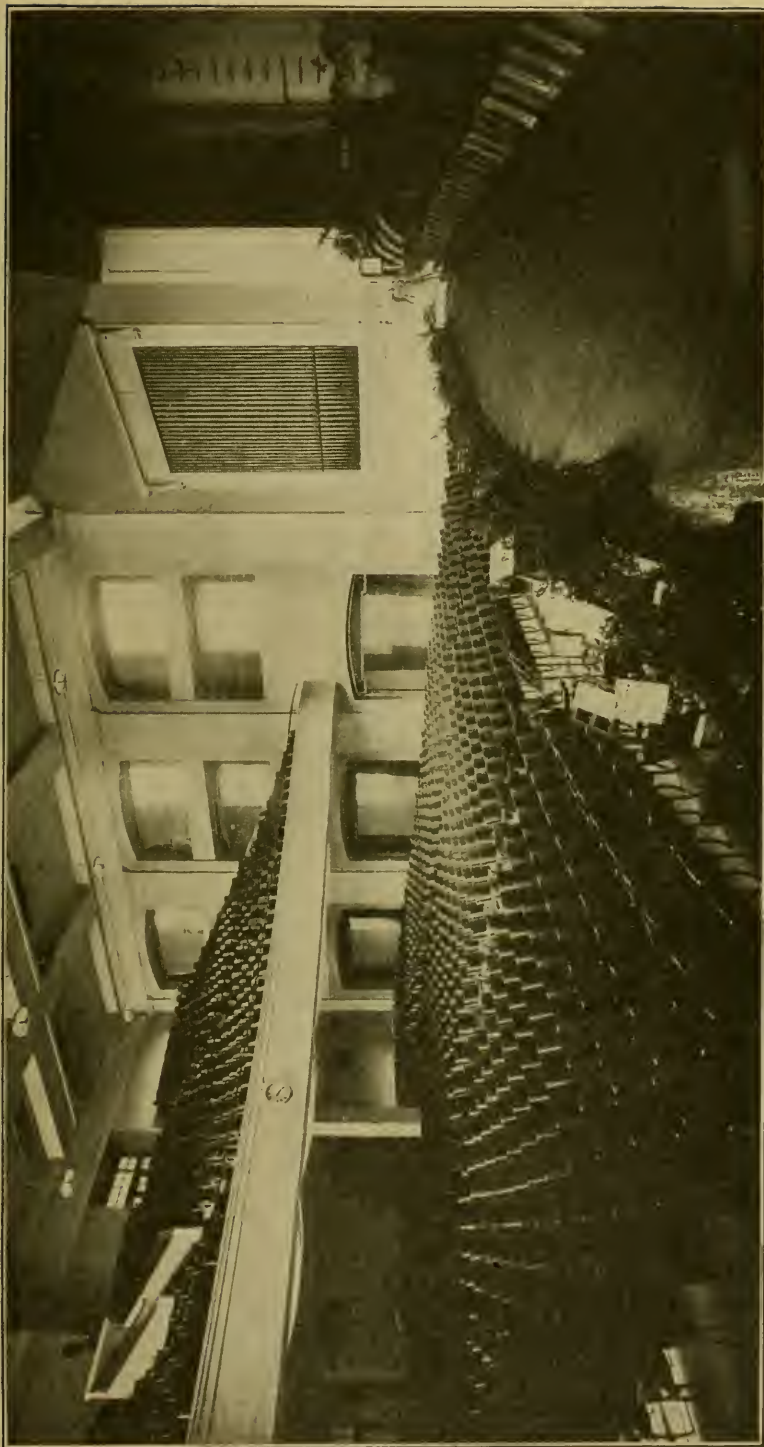
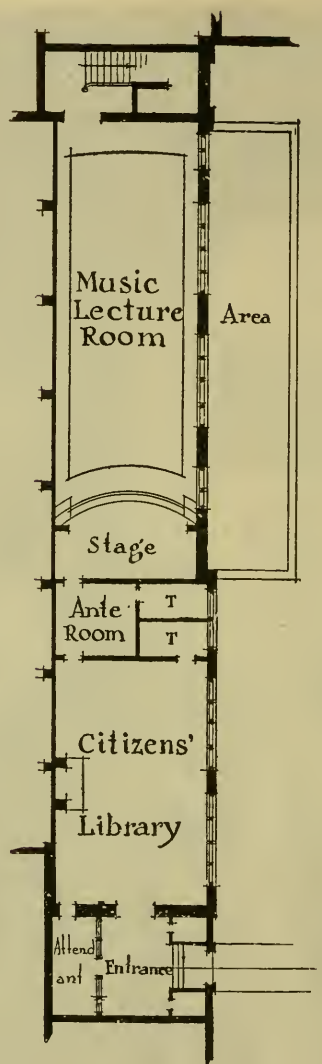


PLATE 17.—AUDITORIUM, CENTRAL HIGH SCHOOL, WASHINGTON, D. C.



Plan of
 MUSIC-LECTURE ROOM
 & CITIZENS' LIBRARY
 Erie Academy High School, Erie, Penna.
 Scale 1 2 3 4 5 6 7 8 9 10 20 ft.

size with suitable walls and protection of windows and lights. The stage can serve as space for spectators in viewing exhibitions. Movable equipment is necessitated and space underneath the stage may be used for its storage. This combination although sometimes necessary is, at best, only a compromise. There can be no sloping floor, much of the gymnasium equipment must be eliminated, and the interior treatment is always a problem. It is only recommended where there are not sufficient numbers to insure a reasonably continuous use of both the auditorium and gymnasium as distinct quarters.

(E) PUBLIC SPEAKING AND MUSIC ROOMS.

Closely allied to the auditorium both in its educational and architectural aspects is the room for public speaking, dramatics, and music. This kind of room is recommended only for large high schools, since the larger classrooms or special rooms equipped for multiple uses serve for these activities in the smaller and medium-sized schools. If the music room has a capacity ranging from 100 to 200 students at a time and is arranged like an auditorium with a sloping floor and small stage, it will give most efficient service. Its interior decoration and seating equipment naturally approximates that of the auditorium.

The location will determine its availability for community uses. If it is placed on the ground floor, provided with an independent entrance, and equipped with motion-picture facilities, it becomes at once a serviceable room for all kinds of club and civic uses for both school and community.

(F) THE WORKSHOPS.

A variety of workrooms is necessary in all high schools. The number and kind are governed largely by the needs and special vocational interests of the community. Owing to this variation no particular procedure can be dictated. There are, however, certain more or less universal types of manual activities that all schools should include, no matter what their location or special tendency may be. Fundamental types of activities from the building industries, wood-working, metal, textiles, and printing belong to these general or universal types.

There is usually a distinction between the shop activities of junior and senior high schools, but the distinction is one of content and method rather than of kind. And the same distinction applies to continuation and evening school shop courses. For the general types of shop activities, therefore, the same kind of shop areas and equipment will serve all classes of students. Local situations and desires will condition quarters for extensions and specializations in the senior high and evening schools.

Shops are best located outside the main walls of the building on the ground floor and connected thereto by corridors. In this location they offer the least disturbance to the rest of the school, are easy of access for supplies, disposal of finished work, and shop refuse. Here they can also take the form of one-story structures with top or factory light, and can be expanded almost indefinitely, restricted only by the site.

In planning shop areas the most approved method consists of large spaces capable of subdivisions by means of unit-type movable partitions. Elasticity of plan is especially desirable in shops and this method will secure it. Proper grouping is also permitted by allowing one or more large undivided areas to each department or general type of work.



PLATE 19.—WOODWORKING SHOP, GROVER CLEVELAND HIGH SCHOOL,
ST. LOUIS, MO.

In planning shop areas the most approved method consists of large spaces capable of subdivision by means of unit-type, movable partitions.



PLATE 20.—WOODTURNING SHOP, GROVER CLEVELAND HIGH SCHOOL,
ST. LOUIS, MO.

Fundamental types of activities from the building and metal trades should be offered in all high schools.



PLATE 21.—METAL WORKING SHOP, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MO.

Shops are best located outside the main walls of the building, on the ground floor and connected thereto by corridors. Here they can take the form of one-story structures, with top or factory light, and can expand almost indefinitely, being limited only by the site.

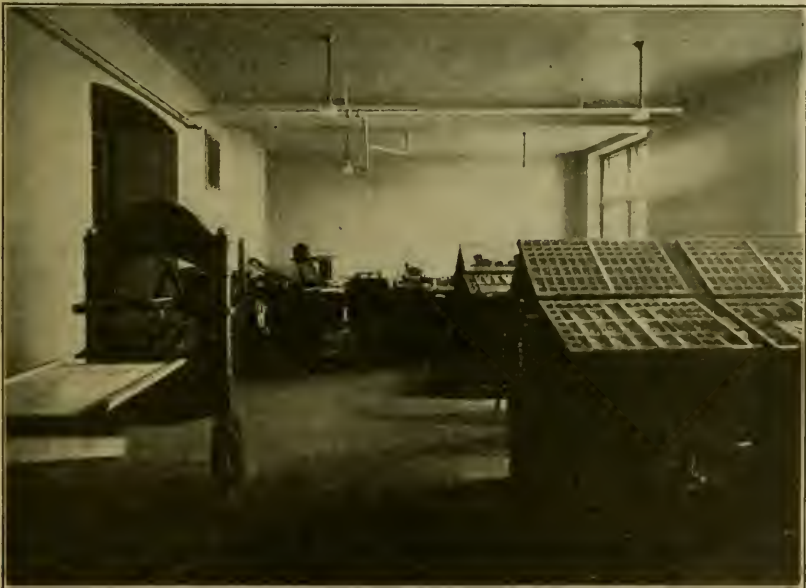


PLATE 22.—PRINT SHOP, CENTRAL HIGH SCHOOL, WASHINGTON, D. C.

(G) COMMERCIAL ROOMS.

Bookkeeping, penmanship, stenography, typewriting, banking, and office practice constitute the general group of commercial subjects. The requirements for these related activities will vary from two rooms of normal size to a large group of rooms of various sizes. As the commercial subjects are becoming increasingly popular, it is advisable to locate the group where it can easily expand. The shop plan of reserving large areas for these activities and subdividing as needs demand by part-glass partitions has proved satisfactory in large high schools.

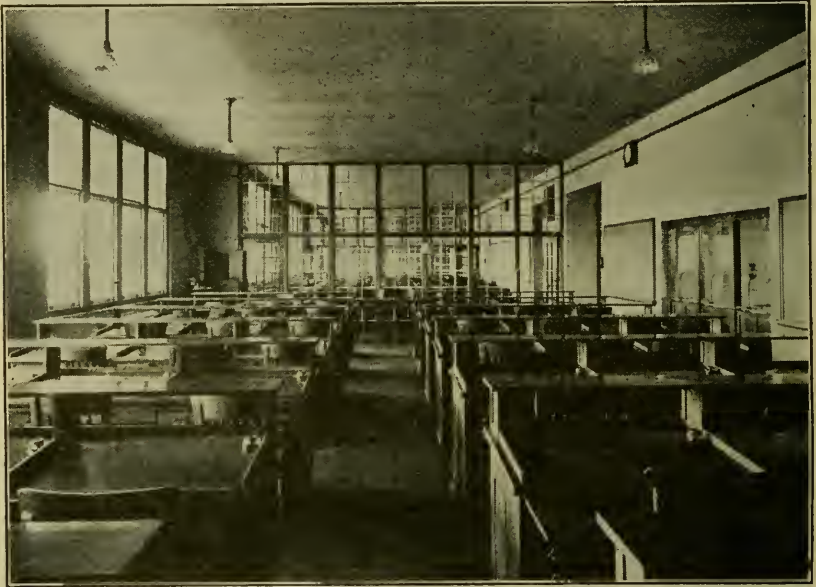


PLATE 23.—COMMERCIAL GROUP, CENTRAL HIGH SCHOOL, MINNEAPOLIS, MINN.

(H) HOME ECONOMICS.

The home economics group includes the laboratories used for teaching foods, clothing, and housekeeping, also millinery, dressmaking, laundering, child care, and home nursing. In some schools the laboratories for the related group of applied arts such as interior decoration, pottery, and textiles are also included and may be arranged adjacent to the home-making group. A classroom may be added for purposes of lectures and discussions in connection with the various activities in this group of laboratories.

It is especially important that the home-economics department be located where the conditions of light, ventilation, and sanitation are conducive to good work and exemplify good American standards of living.

The sizes of home-economics rooms must depend on the type of equipment desired and to some extent also on the method of instruction. Both of these matters need to be determined in advance, particularly the former, for the reason that water and gas supplies and wastes can then be definitely located and installed; otherwise costly changes and much unnecessary expense may result.



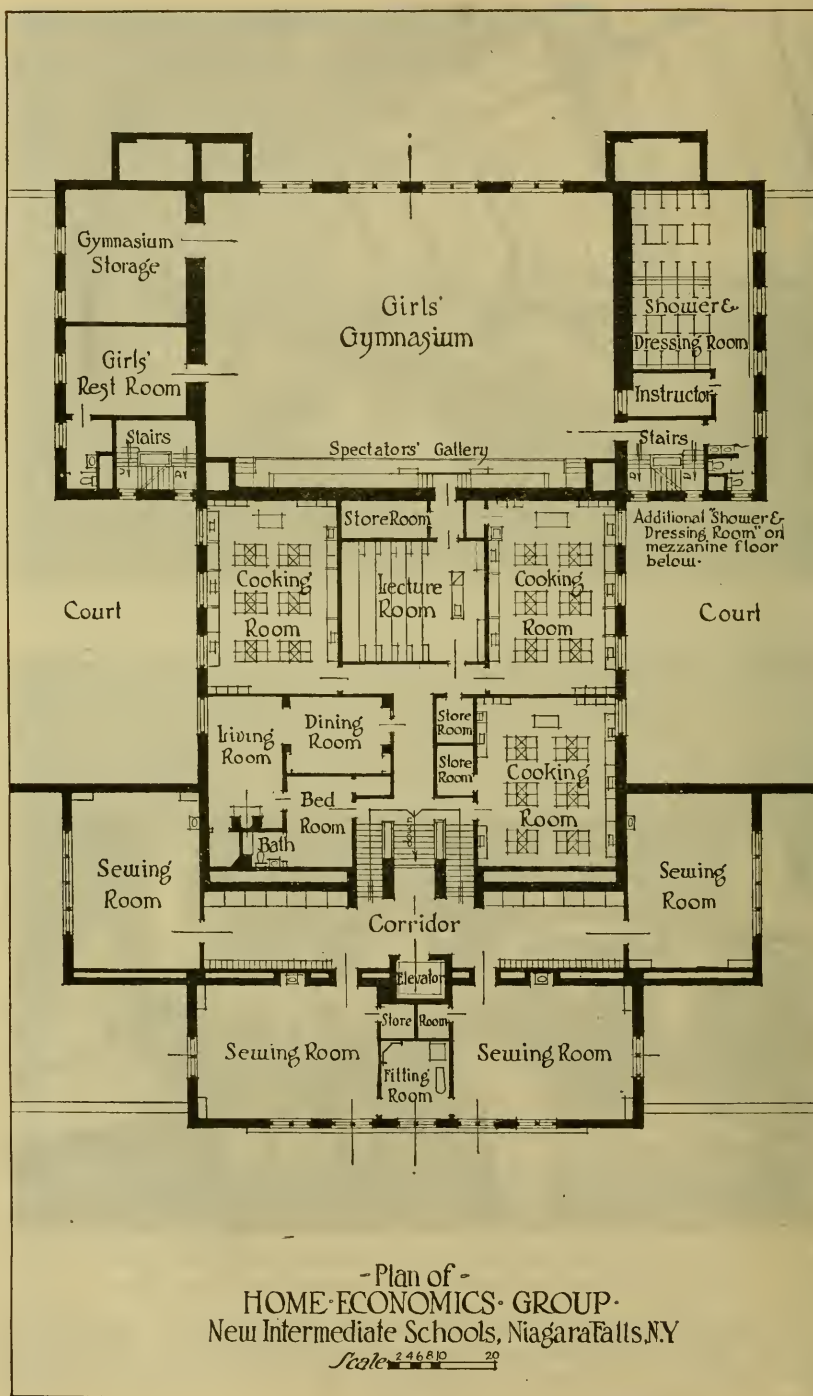
PLATE 24.—ART ROOM, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MO.



PLATE 25.—CLOTHING ROOM, HIGH SCHOOL, FARGO, N. DAK.

Note the harmonious relationship of equipment to size of room.

In small and medium-sized schools, sewing, garment-making, and millinery may be taught in the same room, since the space and equipment required for these distinct lines of handwork are similar; but in large schools it is usually necessary to provide a room for each subject.



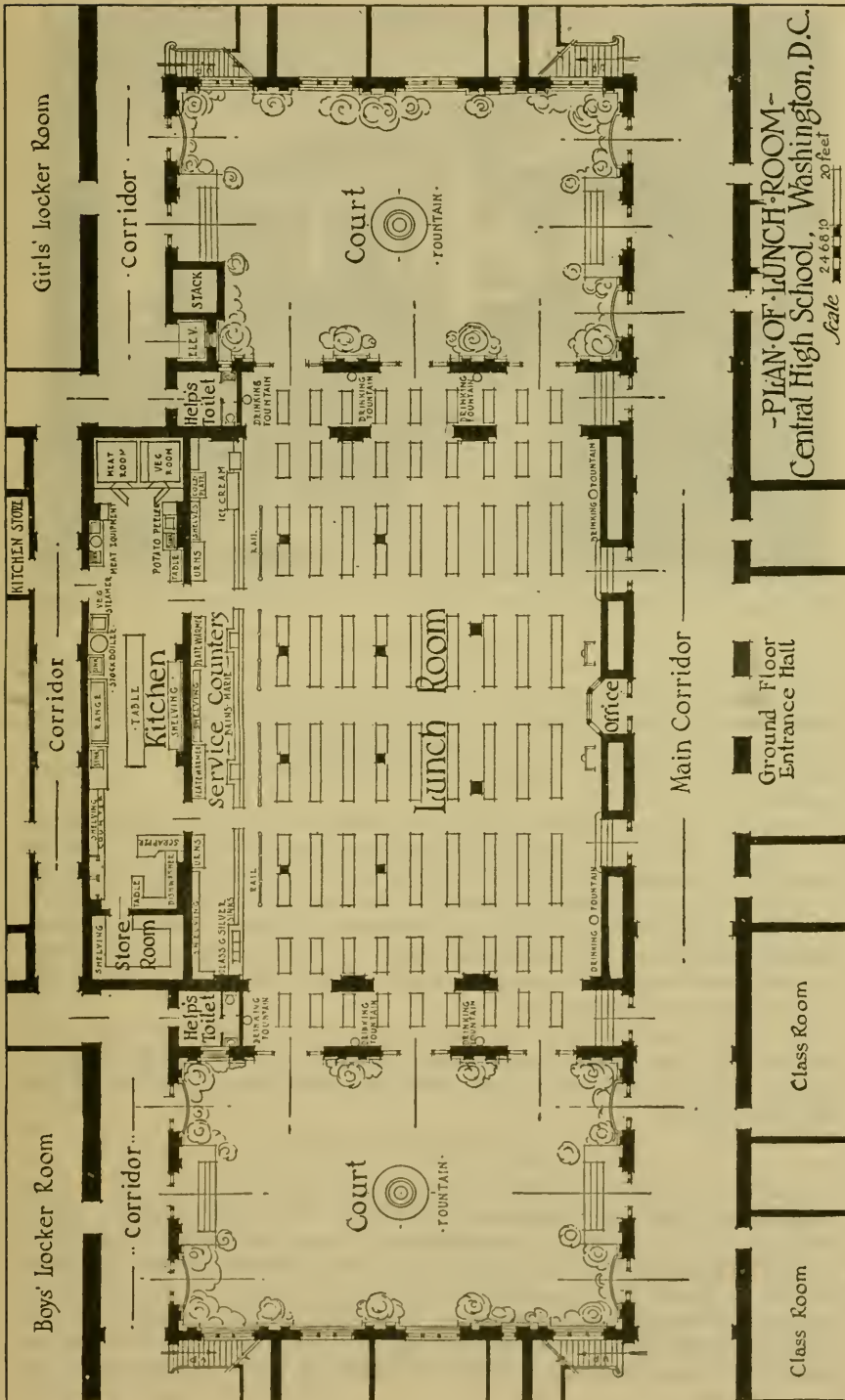




PLATE 28.—LUNCH ROOM, GROVER CLEVELAND HIGH SCHOOL, ST. LOUIS, MO.

(I) LUNCH ROOMS.

The capacity of the lunch room should depend upon the size and the organization of the school. It may range from one-fifth to one-half of the total number of pupils enrolled. It is generally desirable to provide for the latter number so that the entire school may be comfortably seated at lunch in two sections.

For convenience of service, maximum safety, and to avoid congestion in the building during the lunch period, lunch rooms and kitchens should be placed on the ground floor, even though the home economics rooms are on the upper floor. It is frequently a matter of convenience and economy, however, if the lunch room is connected with the home-making rooms. It should be given as much outside light as possible, and, above all, both lunch room and kitchen should be thoroughly ventilated and arranged so that the odors of cooking can not penetrate the building.

The lunch room should have a long service counter between it and the kitchen. The plan should facilitate rapid service and efficient administration. Adequate space for supplies, and for toilet and locker facilities for the kitchen help is necessary.

(J) NONINSTRUCTIONAL SPACE.

From 40 to 60 per cent of floor space in school buildings is ordinarily devoted to uses other than instructional activities. That there should be such a difference in the amount of noninstructional space is evidence that more efficient planning of floor space is necessary. Yet no definite number of square feet can be prescribed on account of the need of variation in different sizes and types of schools: More than 50 per cent of floor space, however, is seldom required. Aside from corridors and stairways, this space is absorbed by offices, rest rooms, storerooms, locker, and accessory rooms. Lunch rooms are

usually included but in some schools they serve definitely for instructional purposes, and so can not always be classified as noninstructional space.

The area of administrative rooms should depend on the size of the school. In small schools the office suite may be limited to a single office and accessory room, unless quarters must be provided for the board of education and superintendent of schools. In large schools the administrative rooms may include a general office, a private office for the principal, a vault for the storage of school records, and a toilet and coat room. They should also include rooms for other supervisory officers aside from the principal. A book room may be added but most schools find it more convenient for book rooms to adjoin supply rooms. The natural location for the administrative rooms is on the first floor near the main entrance.

Teachers' rest rooms may be considered part of the administrative group, although it is not always possible nor even desirable to locate them adjacent to the administrative rooms. Whether or not more than one room is necessary will depend chiefly on the size of the school. Locker and toilet facilities are necessary in the rest room. In medium-sized and large high schools a teacher's workroom should be provided, which may be used as headquarters for teachers not having home room classes. It may well be near the library and equipped with suitable desks or tables.

In many schools it is deemed desirable to centralize storeroom space on the ground floor. In others it is subdivided by reserving space on each floor. Where this plan is used, the rooms may be arranged en stack, and in large plants a freight elevator from basement to each floor opening to the storerooms will be of unlimited service. If an elevator is installed it must be safeguarded in such manner as will preclude the use of it by the students or inexperienced persons, and should be constructed and inclosed in accordance with strict fire-protection methods. Otherwise it may become a serious menace to the safety of the building.

An office and storeroom for the custodian and a locker room with toilets and shower baths for the janitor, are essential. For convenience and accessibility these rooms are best located near the mechanical plant. A direct connection to the secondary entrances is recommended.

Lockers may be grouped in well-lighted and ventilated rooms or they may be placed in alcoves open to the secondary corridors. They may also be recessed along the secondary corridors. In any case they must be provided with a proper system of ventilation. Lockers should never be placed in main corridors, for in this location they constitute a needless obstruction to the free circulation and preclude the proper placing of appropriate decorations such as casts, statuary, and paintings. Many schools use the well-lighted spacious main corridors for permanent as well as temporary exhibits.

The best practice distributes toilets on each floor and arranges them en stack in order to minimize vertical travel and economize on runs of piping. If vestibuled from the corridors, the necessary privacy will be secured. Maximum light and ventilation are mandatory. In fact, a special ventilating fan which can be operated independently of the general ventilating system is frequently installed and is always recommended when direct outside light and natural ventilation are limited.

No definite standards as to number of toilet fixtures have as yet been accepted. It is therefore a matter of judgment. Ordinarily, one seat for every 25 girls and one-half seat and one urinal for every 25 boys serve requirements.

Aside from the washbowls provided in shops, libraries, laboratories, administrative, accessory, and rest rooms, one washbowl for every 50 pupils should be distributed in the toilet rooms.

One drinking bubbler for every 50 pupils is necessary. The distribution of these in the corridors on all floors and in the gymnasiums will give most efficient service. The number in each corridor will depend on needs. Usually the greatest number is required on the main floor. Several drinking fountains are necessary for the grounds, but in the colder climates they must be installed so that the water can be turned off during freezing temperatures. The type of equipment may vary from the simple sanitary bubbler to an elaborate system of circulating ice-cooled water for the building. Fountains of the best sanitary type and self-closing pattern to avoid waste of water are recommended.



PLATE 29.—TYPICAL TOILET ROOM.

Toilet rooms should be distributed on each floor and arranged en stack, in order to minimize vertical travel and economize on runs of piping. They should be equipped with a special ventilating fan which can be operated independently of the general ventilating system.

(K) THE MECHANICAL PLANT.

The mechanical plant includes the boiler room, storage space for fuel and ashes, room for the heating and ventilating apparatus, the water heaters, and the necessary steam accessories. The larger the school the greater the space required.

(a) BOILER AND FUEL ROOM.

The best practice places boiler and fuel rooms outside the main walls of the building, not only for maximum safety, but also for convenience of expansion. Many schools suffer a serious handicap through inadequate fuel storage capacity. In the colder climates it is well to arrange storage space for a full winter's supply. Boiler rooms require convenient storage space for ashes, and a mechanical means for their removal should always be provided.

(b) HEATING AND VENTILATION.

Recent investigation gives some credence to a theory that our present practice of supplying constant quantities of fresh air is incorrect, and that air purification can be secured through recirculation and washing, depending upon the leakage around door and window openings for the fresh air supply. Carbon dioxide is not the cause of bad air as we have been led to believe. Undoubtedly, the essentials to good ventilation are adequate air movement, proper humidity, normal temperature, and the absence of dust and odors.

Ventilating systems are usually planned upon the theory that a constant inflow and outflow of air is necessary to a wholesome condition in the classroom. Many States have enacted legislation requiring the generally recognized standard of 30 or 40 cubic feet per pupil for high schools. Ventilating plants have been designed to warm this quantity and force it through the building and out, without draft or discomfort. In a well-proportioned and properly designed plant it is possible not only to meet this standard, but also to make the inflowing air purer than the air of the playgrounds by washing it and removing all suspended matter. Furthermore, the temperature and the humidity of the air as well as the volume can be kept under reasonable control at all times.

Much of the dissatisfaction among schoolmen with heating and ventilating systems is due to improper design, installation, or handling. The basic principles of the plants are founded upon sound mechanical laws. Experts are required to plan and install them and a thorough understanding of the fundamentals, at least, is required of those who operate them.

In the interest of economical operation the heating system should be installed so that rooms like the auditorium, library, the offices, and others may be separately heated and ventilated. This plan obviates the necessity of operating the entire plant when only part of the building is in use.

In the warmer climates it is entirely possible to combine the heating and ventilating plant in a straight plenum system, heating the building by means of the warm air which constantly passes through it. In the colder climates, however, it is necessary to install direct radiation throughout the building to compensate for the heat losses. Then, again, in the warmer climates, where windows may be opened almost constantly, ventilation may be reduced to auditoriums, toilets, and such other rooms as may specially require it. In some instances



PLATE 30.—A DRINKING FOUNTAIN.

ventilation for these rooms may be omitted. One advantage in ventilating an auditorium in warm climates lies in the fact that with the apparatus properly arranged the comfort of the occupants may be increased by reason of the fact that air motion in warm weather from wind or fans increases bodily comfort.

(C) LIGHTING (ARTIFICIAL).

Evening classes and dark days make artificial lighting necessary in all high schools. Gas lighting will not give the required result without vitiation of the air. The problem is reduced to an electric lighting system of proper distribution, approximating as closely as possible the effect of daylight.

Schoolroom electric lighting is constantly undergoing a change for the better, owing to the more efficient lamp units now being furnished by progressive makers of electrical appliances. The tendency seems to be in the direction of semidirect fixtures properly placed to avoid shadowing. If they are of sufficient size and number to give an average intensity of not less than 5-foot candles over the desk or working area to be served, satisfactory lighting should result. For laboratories, shops, and other quarters where special types of activities are carried on, it is well to increase the intensity to 8-foot candles. Auditoriums, music, and dramatic rooms, and main corridors should have semidirect, or indirect lighting. To secure satisfactory results the foot candle intensity must be computed for these quarters as well as for all other rooms.

In many localities it is advisable for individual school plants to manufacture their own light and power. For large high schools this plan is often a point of economy.

(d) CLOCKS, BELLS, FIRE ALARM, TELEPHONE.

No high school is complete without a program clock and bell system. The simplest system consists of a program or master clock in the general office and bells in the various rooms. These bells are rung automatically for the interchange of classes and dismissal by the program device. More elaborate systems provide clocks in all rooms, synchronized or controlled by the master clock and program device in the general office. Whatever device may be installed, it should be supplemented by a system of hand-operated signals from the office.

A properly installed clock system may serve for fire alarms, but many schools prefer separate signals. In fact, the school codes of some States require distinct fire alarms.

A telephone system connecting the office with at least all departments of the school is necessary in all high schools.

(e) VACUUM CLEANING.

Every high school should be equipped with a portable or other vacuum cleaning system. This method is to be preferred to any other on account of its superior sanitary advantages. The electric driven portable vacuum cleaner with several machines placed on each floor which can be plugged in at frequent intervals in the corridors and in each room is probably the most satisfactory apparatus for general adoption. Cleaning by the vacuum method is harder work and requires more time than cleaning by ordinary methods, and unless apparatus is installed to minimize both of these difficulties it can not be used effectively or economically. The piping of a vacuum-cleaning system is subject to great wear, due to the sand-blast effect of the dirt during its removal. For this reason piping should be installed in such manner as to be readily repaired or replaced.

(L) PROVISION FOR VISUAL INSTRUCTION.

The installation of motion-picture machines and the projectograph in high schools creates problems that the architect must understand and solve if maximum safety and educational returns are to result.

Motion-picture machines are classified by the National Board of Fire Underwriters into two types: (a) Standard machines which require fireproof booths; and (b) portable machines. The standard machines should always be installed in auditoriums since much of the visual instruction is given in connection with auditorium activities. It is scarcely possible and not at all desirable to install fireproof booths in classrooms. The portable machine may be used safely in any room. The lighting circuit of the ordinary classroom is sufficient for the operation of such a machine, as 660 watts meets requirements.

The size of the fireproof booth will depend largely on the type of standard machine installed. It needs to be large enough for the operator to walk freely on either side and back of the machine. The booth, of course, must be built of fireproof materials. The electric wiring must be installed in metal conduit with approved fittings. No portable cords, except those necessary for a proper connection with the machine, should be permitted.

VI. INTERIOR FINISH AND TRIM.

The most successful interior, like the exterior, is simple and straightforward. All moldings and projections need to be eliminated and woodwork reduced to a minimum. Plaster jambs, protected by imbedded metal corner beads, with glazed brick or vitreous tile sills, replace the usual wood trim around all windows. The baseboard should be flush with the plaster wall and coved to the floor. If wainscotings are desired, they should be of vitreous tile or of semiglazed or vitreous brick in light color.

All plaster surfaces should be finished smooth and hard. If painted in lead and oil in appropriate tones and stippled, a finish can be obtained which will be washable. It will also possess maximum light-reflecting qualities under natural as well as artificial light.

The ideal floor for American schools is yet to be found. English wood block floors, much used in England and Scotland, are ideal, but are too expensive to make their use general in America. Maple seems to be the most satisfactory material on account of its close grain and wearing qualities. Where a cheaper floor is desired edge-grained southern pine gives good satisfaction. Cement is used frequently for corridors, but is objectionable on account of its hardness, color, and liability to dusting unless painted. Battleship linoleum is fast coming into favor for classroom floors, as well as for corridors and stairways. As a sanitary floor it perhaps stands in the lead. It is noiseless, resilient, and in its best grades, if properly laid, will outlast oak or maple. Toilet rooms require vitreous or nonabsorbent tile.

VII. EQUIPMENT.

The selection of equipment for the component parts of the building requires as much careful thought as the planning of the building. Lack of foresight and judgment in matters of equipment has resulted in all sorts of improper, impractical, and maladjusted furniture in scores of high schools. Only too frequently do we find interiors, otherwise attractive and planned with the utmost care, marred by poorly designed and ill-fitting equipment.

First of all, the equipment plan needs to be developed with the building plan. In fact, no definite steps can be taken in determining the proper size of classrooms, shops, auditoriums, libraries, and other rooms before determining the character and size of the equipment to be installed. This is the logical procedure, and if it is ignored a number of errors will undoubtedly be discovered when too late to rectify them. The second consideration is the design, workmanship, and finish. These should harmonize with the interior finish and trim of the building. Location of equipment with respect to lighting, circulation, and free working space is the final consideration.

There is a tendency toward more movable furniture for classroom work. Fortunately, there is also a tendency toward improvement in the quality, workmanship, and design of equipment. But whether movable or fixed, whether factory-made or specially designed, the close correlation between the equipment plan and building plan merits full attention.

VIII. SUMMARY.

High school buildings, like all other school buildings, are indigenous and can not be successfully transplanted. Each school building is an individual problem. A successful school in one community may prove an educational misfit in another. Schools must be planned for the communities they are to serve for the reason that the health, educational, vocational, and recreational requirements are variable factors dependent on local needs and desires.

The selection of an adequate and properly located site is of primary importance to provide for future additions, to escape noise and other nuisances, and to give ample playground, lawn, and garden space, as well as to provide a proper setting of the building.

Maximum safety, adequate and properly-distributed lighting, and good ventilation must be the eternal watchwords in the building of schools. They are dependent primarily upon efficient planning and fire-resistive methods of construction. Adequate number and proper location of stairways and exits, the elimination of basements, and the isolation of the mechanical plant are of the greatest importance to safety. Correct orientation, the open plan, adequate and properly distributed window area are the guiding factors in lighting and ventilation.

Elasticity of the building plan is essential in order that the building may be readily adapted to necessary changes in education. The expansion of any unit or group of units should be possible with a minimum expense.

The true worth of a building is in its working efficiency. Therefore, an intimate relationship must exist between the building plan and the educational plan. The success of a school building depends not only upon sound architectural judgment, but also upon a thorough knowledge of schools, methods of administration, and educational tendencies. Such knowledge is necessary on the part of the school planner, if school buildings are to give maximum service.

Although there are two methods of selecting an architect, through competition or by direct appointment, the latter is by far the better plan. The architect who has proved his architectural and executive ability by a number of efficiently planned and well-executed high-school buildings will naturally render the most efficient service.

Architecturally, school buildings both in their interior and exterior treatment should constitute a direct appeal to the best and noblest instincts. In their architectural design, setting, and decoration they should create an environment indicative of the highest standards.

Part II.

I. SMALL HIGH SCHOOLS.

1. ONE-STORY VS. TWO-STORY BUILDINGS.

For small high schools, the one-story plan deserves consideration. Where land is not too expensive, this type may be practical and economical. The individual exits from the various rooms make fireproof construction unnecessary. No space is required for stairways, and lighter construction may be used throughout the building.

For medium-sized and large schools, however, the advantages of the one-story building are not apparent. The building must be spread over a great area, requiring a site of abnormal size for the building alone. Including the out-door physical education areas, the site must be about 15 per cent larger than that required for the more compact two-story building. In the colder climates owing to excessive roof and foundation areas and complications in the heating and ventilating system by reason of excessively long runs of piping, the one-story large school is both impractical and extravagant.

2. THE JUNIOR-SENIOR PLANT.

In a community in which the total number of pupils in the junior and senior high schools does not exceed 1,000, it is advisable to erect a single building for both schools. The first cost of one building of a given capacity is less than two buildings of the same total capacity. The cost of maintenance is also less. Furthermore, the duplication of such facilities as shops, gymnasiums, and auditoriums is avoided with the consolidated plant, to say nothing of the advantages to administration and supervision.

When the student population requires separate buildings for the two schools, proper zoning of the city and a plan for securing the correct relationship between junior and senior plants become necessary. It is obvious that the senior schools need to be central to the groups of junior plants. The distance between the schools depends naturally upon density of population.

3. MULTIPLE USES.

To include as great a variety of rooms in a small or medium-sized high school as is common for a large school would entail excessive cost per pupil, or else result in rooms too small for effective use. If, however, rooms are so constructed that they may be used for different purposes at different times, then a small building can, at reasonable cost, provide for all the more important needs of the school. Therefore, in planning a building for a small or medium-sized high school, the principle of multiple use should be applied. Several applications of this principle are described in the following:

(A) GYMNASIUM-AUDITORIUM.

A single large room may serve as gymnasium and auditorium. For this purpose the floor should be at least 50 by 70 feet and the clear height not less than 18 feet. In order that it may serve as an auditorium, there should be provided a stage of generous size and a convenient storage for auditorium seats and gymnasium floor apparatus. By giving the stage sufficient elevation the space below may be used for such storage.

The superiority of one large room for both gymnasium and auditorium over two smaller rooms is readily understood. A small gymnasium is of little value and an auditorium with a capacity less than 500 is limited as to service.

The combined room should be planned primarily as a gymnasium, with simple and dignified treatment of the walls. Plastered walls must be avoided. Fixed apparatus must, of course, be restricted. It is especially important that the room have direct sunlight and maximum ventilation, both natural and artificial. For this reason the gymnasium should extend to the roof. Top light and extra ventilation can then be introduced if desired.

(B) GYMNASIUM-LUNCH ROOM.

In a small high school, the gymnasium may also serve as a recreation and lunch room. The periods just before and after lunch need not be used in such a school for physical exercises. In this case it becomes necessary for the school kitchen to articulate with the gymnasium. In some plans it will be feasible to have the lunch counter inside the kitchen and accessible to the gymnasium by means of sliding sash above the counter. Where more room is available, a separate lunch room may be placed convenient to both kitchen and gymnasium.

(C) LIBRARY-STUDY HALL, OR LIBRARY-RECITATION ROOM.

In small high schools the library and study hall may be combined in one room or the library may be of classroom size and arranged to care for classes in English, history, or civics under a teacher-librarian. If a small conference room is added, separated from the library by a part-glass partition, a few pupils can use library books while recitations are being conducted by the teacher-librarian. Such a conference room will be useful at other times for committee and miscellaneous conference purposes.

In no case should a school library be placed in a small, inaccessible room, for then it is not likely to be kept open and made attractive. A collection of books, no matter how excellent, does not constitute an effective library. Efficiency can only be stated in terms of actual use.

(D) PHYSICS-CHEMISTRY LABORATORY.

Physics and chemistry may be taught in the same laboratory if care is exercised in the selection of equipment. The convertible type of laboratory table is most desirable in a combination room of this kind. It is advisable to include a set of recitation chairs. Ample storage for the physics apparatus so that it will not be injured by the chemical fumes is an important factor.

(E) BIOLOGY-AGRICULTURE LABORATORY.

Biology and agriculture may be taught in the same room, since there is a close relationship between the two subjects, and also since the laboratory for either subject should be located on the floor most accessible to the grounds. The fixed equipment, if carefully selected, will serve for both subjects.

II. JUNIOR ANNEXES TO HIGH SCHOOLS AND THE ALTERATION OF OLD BUILDINGS.

Planning annexes to present school buildings, elementary or high, for junior high-school uses should involve no serious difficulties, providing the site is of adequate size to enable their erection without impairing the lighting and ventilation of the existing buildings.

Old buildings of the traditional type are rarely planned for easy and logical alterations. Frequently the most satisfactory solution is the adoption of the group plan. But this can not be attempted unless the site is of such generous proportions as will admit of additional buildings, their proper grouping with one another for correlation of departments, and the preservation of light and air. In some cases the old building may be utilized for administration rooms and those departments best suited to its plan. The science, shop, auditorium, athletic, and other activities can then be arranged around it in buildings of moderate size. These may be added from time to time with the growth of the school, or as the program of studies may require. In any event, the plan should be arranged with a view of finally replacing the old building with a new one, fitting it in as efficiently as possible with the group plan adopted.

Every problem in the alteration of old buildings and the building of annexes to present buildings must necessarily be an individual one. It can be successfully solved only by a careful consideration of all elements involved. It may be helpful to include with this report an example of a common problem.

ALTERATION PROBLEM.

In the problem presented we have an old high-school building, typical of those erected about 1900, and, as was usual at that time, without regard to the possibilities of extension for future growth. It is located upon a site adequate perhaps for present needs, but it is desired to enlarge the manual training and domestic arts accommodations, add auditorium and gymnasium facilities, a new heating and ventilating system, and other features which go to make up a well-correlated high school for junior as well as senior purposes.

The building is a three-story one of ordinary construction. It has an assembly room occupying the greater portion of its second and third floors. This it is desired to alter into classrooms. The taxing or bonding power of the district will not furnish sufficient means to fireproof the present building. Indeed, it will barely suffice to provide the additional rooms. At the same time, the high-school accommodations must be doubled to meet existing demands.

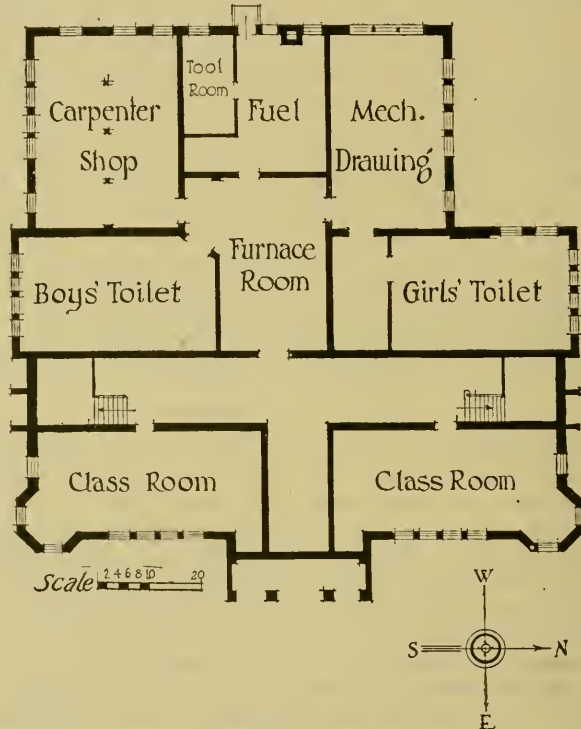
In writing about the building, the chairman of the building committee says:

Our building has been built about 15 years, and lacks a lot of being modern. But I believe it is possible by alterations and annexes to make it an adequate and satisfactory building at a much more moderate cost than a new one. Besides, I believe we shall have no trouble in voting bonds to remodel and I fear we should for a new building. If it were necessary to put up a new building, we could not vote enough bonds for 8 or 10 years because of the limitations and the present bonded indebtedness, but we can vote enough to remodel and add to the present structure, and there is a sentiment here in favor of so doing.

Such problems are typical of those confronting schoolmen everywhere. In their solution the essentials to be kept in mind generally are: A gymnasium and auditorium arranged to serve maximum school and community uses, facilities for vocational work, enlarged space for the heating and ventilating plant, accommodations for a double enrollment, and the maintenance throughout of safety, sanitation, and proper lighting.

Referring again to the problem, it may be stated that the changes in the structural or bearing walls of the old building should be of such a nature as to require no serious alterations or expense. On account of the nonfireproof character of the building, additional stairways may be necessary. In the alteration of old buildings for high-school uses, it is possible to provide additional stairways and exits and locate them so as to eliminate all danger.

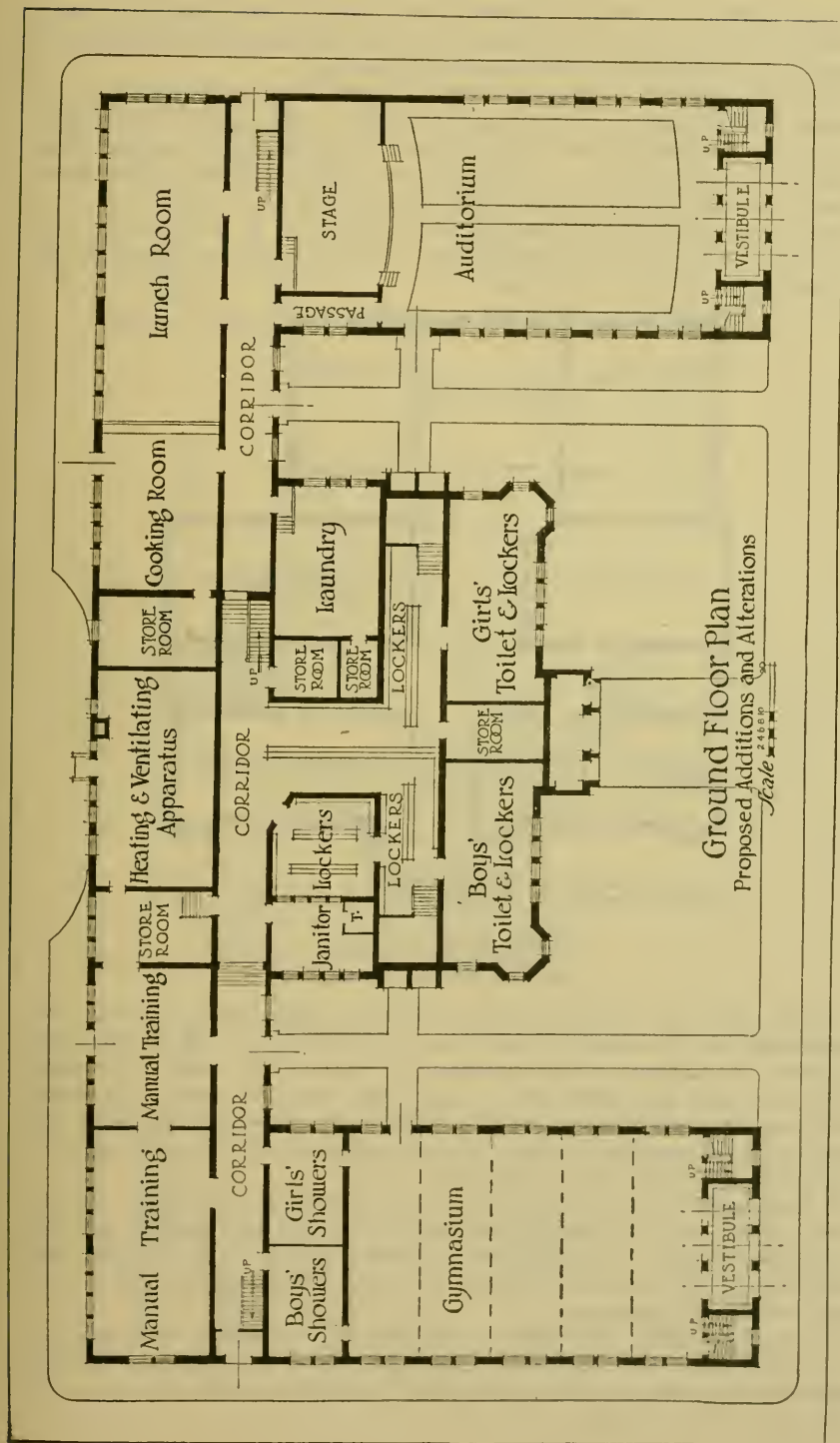
The plans presented herewith give the arrangement of each floor of the old building, parallel with the proposed new one, in such manner as will enable them to be studied together. It will be noted that the auditorium and gymna-



ALTERATION PROBLEM.
Ground-floor plan, old building.

sium have been placed at grade along the north and south lot lines, accessible for general as well as school uses, and in such a position that the lighting of the rooms in the old building will not be impaired. The gymnasium is of standard size, and is provided with a spectator's gallery, and locker and shower bath facilities for both boys and girls. The auditorium with a seating capacity of 750 is placed symmetrically with the gymnasium. A cross corridor has been carried entirely through the ground floor from north to south uniting the group. Behind this the manual training and domestic art departments have been placed.

In the arrangement of the home economics rooms, the cooking room is placed next to the lunch room. The latter is provided with a general storeroom for supplies. The laundry is placed in the old building, near at hand, and the sewing room and housekeeping suite are arranged over the lunch room. The division of the home economics group is, of course, unfortunate and but serves

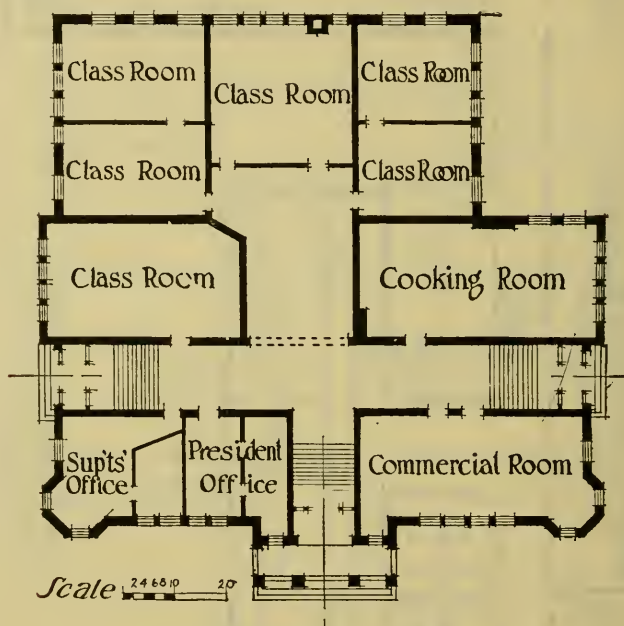


ALTERATION PROBLEM.

to prove that in an alteration problem the approach to the ideal is, in many cases, somewhat remote. On the other side of the building there are three shop rooms and a generous room for mechanical drawing.

The large rooms in the basement of the old building, entirely unfitted for classes, can be used for locker rooms and toilets. The removal of the furnaces gives additional space, allowing the full complement of lockers to be installed in such manner as to bring about a logical division of the basement for privacy without disturbing the circulation of the corridors.

Steam will be furnished from a municipal plant. It is necessary only to provide space for the ventilating fans, and this is located central to the enlarged group in the old building.

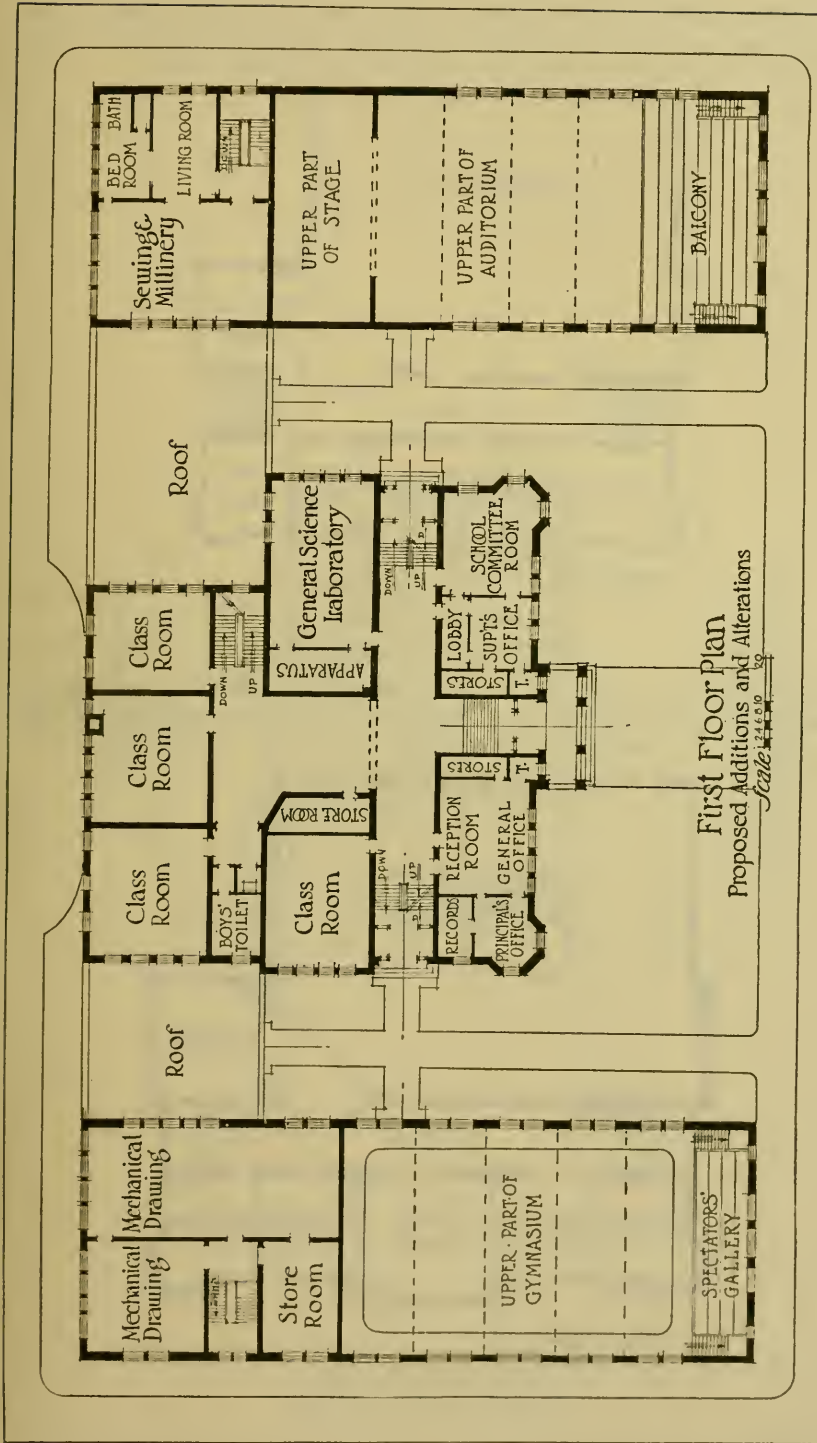


ALTERATION PROBLEM.
First-floor plan, old building.

On the first floor of the old building, the large rooms along the front give opportunity for the administration room of the school, as well as offices for the board of education and superintendent of schools. The rooms of abnormal depth now used as a classroom and a cooking room are reduced in depth, thus improving their natural lighting, and at the same time providing the necessary floor space for a general science laboratory with apparatus room, a classroom, and a large general storeroom.

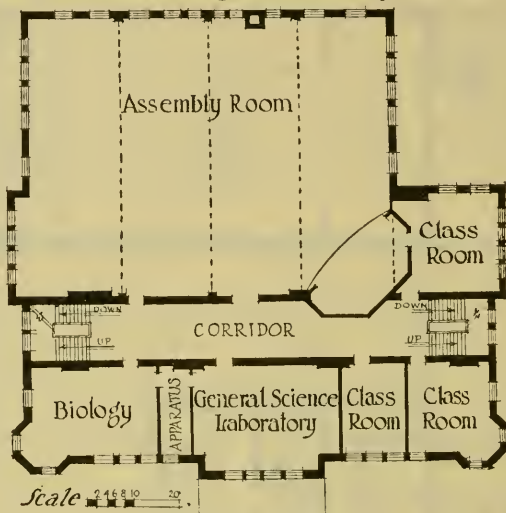
A girls' toilet is moved to provide for the additional stairway, located in such manner as will improve the general safety of the building and the circulation between the rear basement corridor and the upper floors of the old building. The remaining space on this floor, without serious changes, gives three satisfactory classrooms.

On the second floor, the space now occupied by the assembly room, provides for a laboratory, the commercial department, and three classrooms, and the space along the front gives opportunity for the introduction of a library study room and two class units.



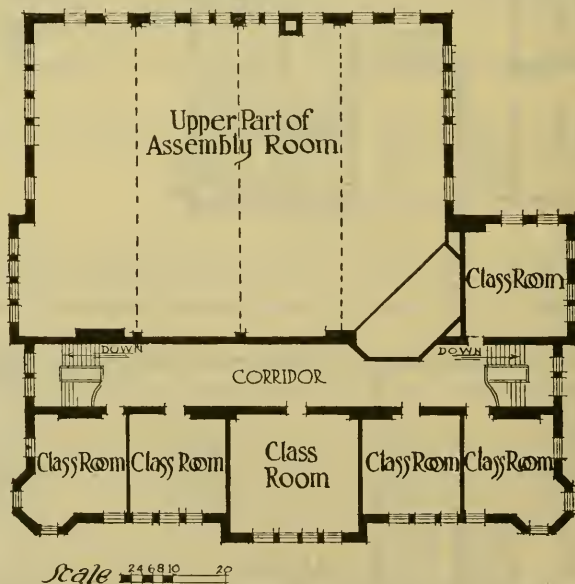
ALTERATION PROBLEM.

The third floor space, now occupied by the upper part of the assembly room, enables the introduction of another laboratory, four classrooms and an art room, and the five classrooms along the front may remain intact.

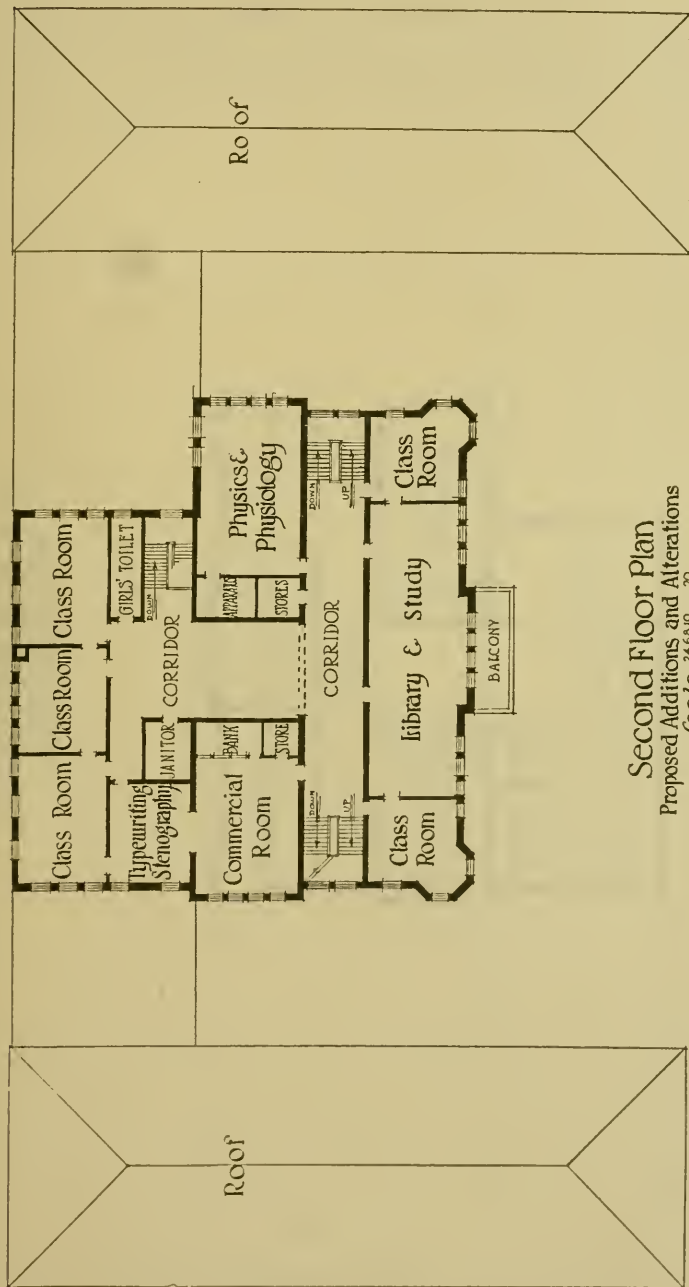


ALTERATION PROBLEM.
Second-floor plan, old building.

Thus provision is made for a total of 34 classes with study, gymnasium, auditorium, and lunch facilities, within the prescribed limits of the site without loss of natural lighting and at minimum cost to the community.



ALTERATION PROBLEM.
Third-floor plan, old building.



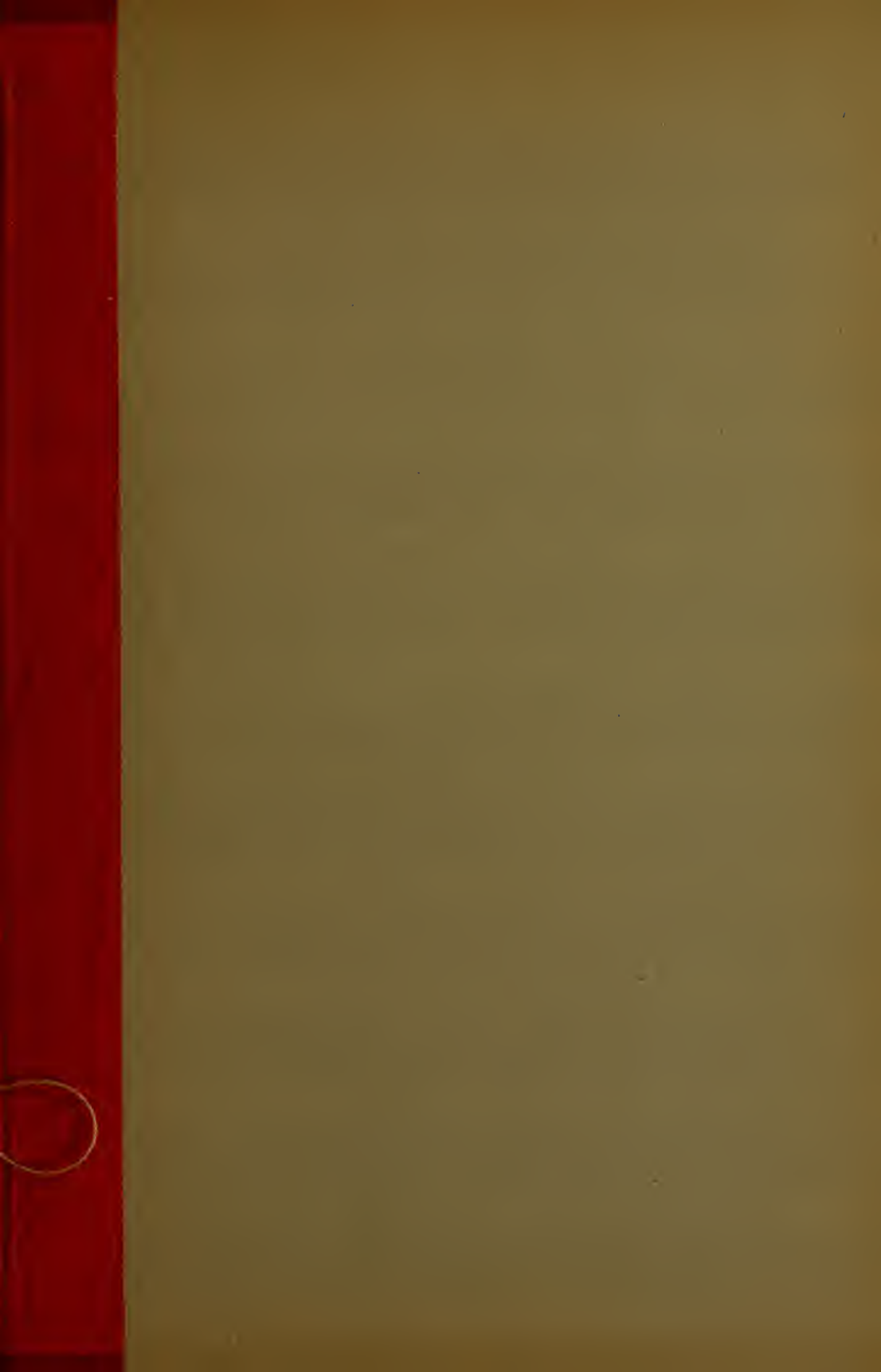
Second Floor Plan
Proposed Additions and Alterations
Scale 1/4" = 1'-0"

ALTERATION PROBLEM.

From the solution described and illustrated it must be apparent that the successful working out of the alteration of an old high school for enlarged school uses can not be given in any but the most general terms. A careful examination of the plan presented herewith must make it apparent to the reader and observer that at best the solution of the problem is but a series of compromises. The degree of success of such altered and enlarged buildings is entirely dependent upon the care with which all the controlling elements are weighed and measured.







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